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Graduate School Issue

# Bulletin of the University of New Hampshire



# The Graduate School 1975-76

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# Graduate Degree Programs

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## **Master of Science**

Animal Sciences  
Biochemistry  
Biology  
Botany  
Chemical Engineering  
Chemistry  
Civil Engineering  
Electrical Engineering  
Entomology  
Genetics  
Geology  
Home Economics  
Mathematics  
Mechanical Engineering  
Microbiology  
Music Education  
Natural and  
Environmental Resources  
Physical Education  
Physics  
Plant Science  
Zoology

## **Master of Arts**

Economics  
English  
French  
German  
History  
Music  
Political Science  
Psychology  
Sociology  
Spanish

## **Master of Arts in Teaching**

## **Master of Science for Teachers**

Biology  
Chemistry  
English  
French  
Mathematics  
Physics  
Spanish

## **Master of Occupational Education**

## **Master of Business Administration**

## **Master of Education**

Administration and  
Supervision  
Counseling and  
Personnel Services  
Early Childhood  
Elementary Education  
Reading  
Secondary Education

## **Master of Public Administration**

Political Science

## **Doctor of Philosophy**

Biochemistry  
Botany  
Chemistry  
Economics  
Engineering  
English  
Genetics  
History  
Mathematics  
Microbiology  
Physics  
Plant Science  
Psychology  
Sociology  
Zoology





# Graduate Education At the University of New Hampshire

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The University of New Hampshire awarded its first Ph.D. degree in 1896, placing it among the first American universities to award that degree. The development of doctoral programs in their present form began in the 1950s. The Graduate School was formally organized as part of the University structure over 40 years ago with the appointment of its first dean. The Graduate Council, composed of faculty and student representatives elected by their respective constituencies, serves in an advisory capacity. The graduate faculty supervises graduate study at the University.

The University of New Hampshire, guided by the quest for academic excellence, has followed a gradual and systematic approach in the development of graduate programs. The development of programs, which will be commensurate with institutional resources and the needs and opportunities found in New Hampshire and New England, has been the goal of this development. Coordination of programming among the units of the University System of New Hampshire is one of the considerations in all program development. The Graduate School has sought to avoid the pitfalls of overexpansion and has had significant success in placing its graduates in positions that utilize the skills acquired during their graduate study. The Graduate School cooperates with other graduate schools in New England to coordinate the further planning and development of graduate education in the New England region. The Graduate School participates in the New England Regional Student Program. This program provides for New England residents to be charged in-state rates when enrolling in a graduate program offered at one of the New England state universities (but not at the state university in the student's home state). Additional information concerning this program may be obtained from the New England Board of Higher Education, 40 Grove Street, Wellesley, Massachusetts 02181. See p. 11 for application procedures under this program.

## Master's Programs

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The University offers master's degree programs in a wide variety of disciplines which serve both as professional, terminal degrees and as intermediate degrees for those intending to pursue further graduate study. Master's programs at the University of New Hampshire have been carefully developed and are reviewed by the graduate dean and faculty to ensure that they provide optimal educational opportunities in the state. In most programs students can elect options that will either permit them to study one aspect of a discipline in depth by preparing a thesis, or to gain a broader mastery of a discipline by electing to take course work in lieu of a thesis. While master's programs are generally designed to be completed in a calendar year of full time study, it is also possible to pursue many programs on a part-time basis. Recipients of the University of New Hamp-

shire master's degrees have found employment in education, government, and business organizations in the state and nation; while others have been successful in further graduate study.

## **Doctoral Programs**

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The University offers Ph.D. programs in those disciplines where it has both faculty resources and facilities to support advanced graduate education of high quality. In developing doctoral programs care has been taken to ensure that the programs will make a significant contribution to the opportunities for doctoral education in the New England region. Doctoral education properly focuses upon preparing the student to contribute to the growth of knowledge through research. However, since a large percentage of doctoral students will find employment in higher education, most doctoral programs provide an opportunity for students to prepare for their role in higher education through work as teaching assistants and seminars in teaching led by experienced faculty members. This preparation for the student's future role as both developer and communicator of knowledge has enabled recipients of the doctoral degree from the University of New Hampshire to obtain attractive teaching and research positions.

## **Interdisciplinary Programs**

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Many of the problems faced by modern society demand that students be trained in more than one of the traditional academic disciplines. Consequently, the Graduate School seeks to foster the development of programs which involve the faculty of more than one discipline or department. This may be done through such formal organizations as the Genetics Program, which involves geneticists from many departments in both master's and doctoral programs; or the Institute of Natural and Environmental Resources, which brings together resource economists, foresters, wildlife specialists, and soil and water scientists to address the problems of our environment; or the Intercollege Biological Sciences Organization, which makes the resources of the biological science departments available to students in master's programs designed for secondary and junior college teachers.

Other forms of cooperation are less formal, as when students from one department work with faculty from other departments to develop a program, thus combining the strengths of several disciplines. An example of this is the Soil and Water—Chemistry Program, which involves faculty in soil and water science cooperating with chemistry faculty. Students in zoology frequently work with faculty in such other departments as animal sciences and entomology to broaden





their scope in their graduate programs. In the social sciences, the psychology and sociology departments cooperate in a social-psychology doctoral program. The Engineering Ph.D. program is a cooperative, interdisciplinary effort of the electrical engineering, civil engineering, mechanical engineering, and chemical engineering departments.

Students in all programs are encouraged, with the consent of their adviser, to take those courses outside their discipline which are appropriate to their professional goals.

With its location on the banks of the largest estuary on the Atlantic Coast, the University has long had an interest in marine affairs including both engineering and biological aspects. Two interdisciplinary programs focus on this area.

1. An example of University interest in marine science is the recently constructed Jackson Estuarine Laboratory and the research vessel, R/V *Jere A. Chase*. A graduate student who wishes to emphasize marine science or oceanography in his graduate work may do so by selecting courses in the departments of biochemistry, botany, earth sciences, microbiology, and zoology. For further information, write to the Office of Marine Science and Technology, Kingsbury Hall.

2. The Engineering Design and Analysis Laboratory (EDAL) is an interdisciplinary faculty group, mainly from the College of Technology, whose purpose is to involve both faculty and students in realistic and challenging ocean engineering projects. Students in master's programs in chemical, civil, electrical, and mechanical engineering, or the Engineering Ph.D. program may elect an ocean engineering orientation. For information regarding EDAL activities, write to the Office of Marine Science and Technology.

# Teaching, Service, and Research

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Research provides a continuing transfusion of knowledge that enhances the level of instruction, extends the frontiers of knowledge, and makes human progress possible. Research contributes to graduate education directly by creating an opportunity for graduate students to learn research methods by participating with their instructors as part of research teams. The goal of research, of course, is to share the University's discoveries and applications with other scholars and the people of the state and region. The dean of the Graduate School is also director of research and in that capacity works to ensure that the University's research efforts support its educational efforts.

## Research and Service Facilities

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One of the largest research and service units of the University is the Agricultural Experiment Station which, in conjunction with the Cooperative Extension Service, provides research, information, and testing services for New Hampshire's agricultural industry. The Center for Industrial and Institutional Development, the Water Resources Research Center, and the Resources Development Center provide more specialized research and service to New Hampshire businesses, industry, and government. The Public Administration Service serves as a consultant group for town and city officials; and the Bureau of Educational Research and Testing serves New Hampshire educators. The service activities of all such units afford graduate students an opportunity to apply the skills acquired in their graduate programs.

**The Jackson Estuarine Laboratory**, the University's newest research facility, is an 8,400-square-foot structure located about five miles from the University campus on the shore of Great Bay at Adams Point. The tide-water area in the Great Bay estuarine complex covers more than 15,000 acres. Tidal water enters and leaves via the Piscataqua River; some 13.5 billion gallons ebb and flow on an average tide of eight vertical feet. The continental shelf of the Gulf of Maine is approximately thirteen miles steaming distance from the laboratory. Marine research facilities for the departments of biochemistry, botany, microbiology, zoology, and earth sciences are located in the laboratory. Also included are: a circulating seawater system; a shop for maintenance of oceanographic gear; a small library-conference area; a research vessel, *R/V Jere A. Chase*; and a pier for docking research vessels.

The Engineering Design and Analysis Laboratory interdepartmental faculty group and graduate students participate mainly in marine-oriented engineer-



## Library



ing projects. The Ritzman Animal Nutrition Laboratory and the Space Science Center offer sophisticated campus research facilities.

Among the other research instruments available on campus are a mass spectrometer, an optical rotatory dispersion spectrophotometer, a nuclear magnetic resonance spectrometer, a Van de Graaff generator, an amino acid analyzer, electron microscopes, a gas chromatograph, an electron spin resonance spectrometer, and the IBM 360/50 computer center. Students from all disciplines may make arrangements for their use.

**The New England Center for Continuing Education** is adjacent to campus. This architecturally striking complex was built with a gift from the Kellogg Foundation and is supported by the six New England state universities. The Center provides residence and conference facilities for a wide variety of adult educational programs. Facilities include a closed circuit TV system which permits conference programs to be reviewed in the participants' rooms.

The University Library houses 680,000 volumes, 5,200 periodicals, and substantial microform and audio-tape collections. Specialized subject collections are housed in four branches: chemistry in Parsons Hall, engineering and mathematics in Kingsbury Hall, biological sciences in Kendall Hall, and physics in DeMeritt Hall. Each branch is administered by a librarian with special skills in the appropriate subject area. Media Services, a department of the library, offers a large film collection, equipment loans including projectors and portable TV cameras and monitors, photographic and graphic design assistance, and A-V project consultation.

Special services offered to graduate students include graduate study areas, with assignable locked book trucks. Graduate students may use the Interlibrary Loan System to supplement material available in the University Library. The library is a U.S. government document depository and the staff includes a full-time documents librarian.

The Dimond Library serves the University and the town of Durham. A graduate student's spouse and children may use the facilities which include a professionally staffed children's room.

During the regular academic year, the library is open seven days a week. On vacations and during the summer, a more limited schedule is in effect.

The library contains a study room which is open 24 hours a day, seven days a week, throughout the entire year.

# Admission, Financial Aid, Academic Regulations

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## Admission

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### Requirements

Admission to the Graduate School may be granted to graduates of all colleges and universities of approved standing, provided the applicant's undergraduate record is satisfactory. The sex, race, religion, color, and national origin of applicants is not considered in the admissions process.

The number of applicants to some graduate programs annually exceeds the number which can be accommodated by the University faculty and facilities. Thus, in some instances, otherwise qualified applicants may be denied admission because of these constraints.

Applicants for admission must present evidence that they have had the necessary prerequisite training to enable them to pursue the graduate program for which they are applying. Candidates for admission must have a superior undergraduate record. An applicant who has undertaken graduate work at another institution should have completed the courses or program undertaken with a record which is equivalent to that required for graduate students to remain in good academic standing at the University of New Hampshire.

Individual departments may specify special requirements which applicants must meet; such requirements may include the scores received on the aptitude and appropriate advanced sections of the Graduate Record Examination or the Aptitude Test for the Graduate Study of Business, or specific undergraduate preparation. The program descriptions listed in this catalog and the information sheet supplied with the application forms should be consulted for these special requirements.

Applicants seeking admission to programs leading to the Master of Science for Teachers degree must meet one of the following admission requirements: 1) completion of education courses sufficient for certification, 2) three years of teaching experience, or 3) a current full-time teaching position.

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### Application Procedures

**An applicant for admission must submit directly to the dean of the Graduate School, Social Science Center, University of New Hampshire, Durham, New Hampshire 03824, the following materials:**

1. The official application forms for admission to graduate study (available from the Graduate School).
2. Two copies of official transcripts showing the grades earned in all of the applicant's previous academic work (graduate and undergraduate).
3. Three confidential letters of recommendation from persons in a position to judge the applicant's preparation and fitness for graduate work, e.g., previous instructors or coworkers of the applicant. Letters must be forwarded directly by the referee to the Graduate School. Material from college placement offices which was not prepared within the last twelve months is not acceptable.
4. A \$10 application fee. This fee is nonrefundable.



## **Applicants from Foreign Countries**

5. Any additional materials, such as scores achieved on the Graduate Record Examination or Admission Test for the Graduate Study of Business, which are required by the department or program to which the applicant is applying. Such scores must be forwarded directly from the testing agency.

6. Completed "Statement on Residence for Applicants to Graduate School at UNH." This form will be included with application forms.

All application material becomes part of the permanent records of the University of New Hampshire and will not be returned.

When the application and all of the required supporting material has been received, the application is forwarded to the appropriate department for review. This review normally is conducted by a departmental committee composed of graduate faculty members. The dean of the Graduate School carefully reviews the applicant's file and the department's recommendation. After making the final decision, the dean of the Graduate School will inform all applicants of the action taken upon their applications.

Since the specific criteria for admission are different for each program in the Graduate School, it is impossible to itemize all of the factors which are weighed in the admission process. Because of this, the Graduate School has not established such specific criteria as the minimally acceptable scores on a standardized test, e.g. the GRE or ATGSB. All of the material which is submitted as part of an application will receive careful consideration.

New England residents wishing to be considered for resident tuition charges under the New England Regional Student program should consult the New England Regional Student Program Graduate Level booklet, available from the New England Board of Higher Education, 40 Grove Street, Wellesley, MA 03181. If the program in which an applicant is interested is listed in that booklet as being available at the University of New Hampshire to residents of the applicant's home state, the applicant should have the following information forwarded to the Graduate School at the University of New Hampshire: 1) A letter from the dean of the Graduate School at the state university in the applicant's home state, stating that the applicant's proposed program is not available in his home state. 2) Proof of residency in the eligible New England state.

In addition to the material noted above, all applicants from non-English-speaking countries must furnish proof of their proficiency in English by submitting scores achieved on the Test of English as a Foreign Language administered by Educational Testing Service. Arrangements for taking this examination should be made directly with Educational Testing Service, Box 899, Princeton, New Jersey, USA, 08540.

Because of the time involved in processing applications from residents of foreign countries, completed applications and supporting documents should be received at the Graduate School four months prior to the semester for which the admission is desired.

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## Application Dates

Completed applications and supporting documents should be submitted before July 15 for the first semester, before December 15 for the second semester, and before April 1 for the summer session. There is no guarantee that applications submitted after these deadlines can be acted upon in time to permit registration in the desired semester. Applicants for financial aid must submit completed applications and supporting documents for admission and financial aid prior to February 15.

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## Types of Admission

**Regular Admission:** Regular admission may be granted to those applicants whose academic records and supporting documents suggest that they are fully qualified to undertake graduate study in their chosen field.

**Conditional Admission:** Conditional admission may be granted to those applicants whose academic records indicate deficiencies but suggest some promise of success in graduate study. Students granted conditional admission must meet the specific requirements stated at the time of their admission. Conditional admission will not be granted to applicants who reside in foreign countries.

**Special Students:** Individuals holding baccalaureate degrees who wish to register for courses, may do so with the approval of the instructor and dean of the Graduate School. Such students are not admitted to the Graduate School and are not candidates for a graduate degree. Special students must complete the special student registration form which is available during the registration period each semester. This form must be filed by all special students whether they register for day courses at the University, or courses offered by the Division of Continuing Education, at the Merrimack Valley Branch, or in the summer session. Special students are not required to file an application to the Graduate School.

If a special student is subsequently admitted to a degree program, a maximum of nine credits earned in the University System of New Hampshire as a special student may, upon recommendation of the department, be applied to that program. Ordinarily, the nine credits would be selected from courses completed or in process on the date when the official letter of admission is written.

**Applicants Not Admitted:** Applicants who are denied admission are advised that they may be reconsidered only if there is additional, significant material furnished such as: evidence of additional academic achievement, or more recent and significantly improved GRE or ATGSB scores.

**University of New Hampshire Seniors:** Qualified senior students in the University of New Hampshire may be admitted to the Graduate School, and must have been admitted before enrolling for courses for graduate credit. Such seniors should follow the application procedure outlined above, and should file their applications by the specified dates.

Upon recommendation of the department, superior University of New Hampshire senior students may petition the Graduate School to be allowed to count credits for up to two 800-level courses toward both a bachelor's and master's degree, provided the student has been admitted to the master's program.

**University of New Hampshire Employees:** Members of the University of New Hampshire faculty with the rank of assistant professor or above will not be admitted to the graduate programs. Full-time staff employees of the University, who do not hold academic rank, will not ordinarily be admitted to doctoral programs in the department in which they are employed. The above regulations pertain even for individuals who resign their positions.

**Honorary Fellows:** Qualified scholars who may temporarily desire the privilege of using the library and research facilities of the University and who are not candidates for a degree may, upon recommendation of the dean of the Graduate School and the approval of the president of the University, be appointed Honorary Fellows without stipend. Honorary Fellows shall not be required to pay any charges except the cost of unusually expensive supplies or equipment.

## Financial Information

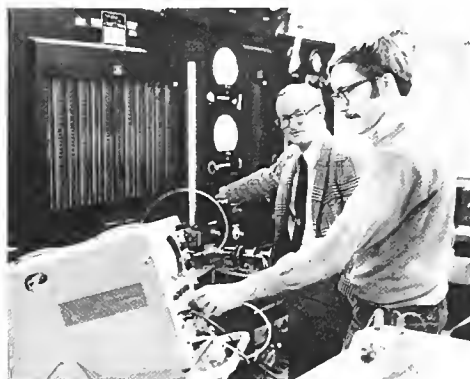
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### Course Charges and Fees

Graduate students pay course charges according to the number of credits and level of courses for which they enroll each semester. For 700- and 800-level course registrations this rate is \$42.00 per credit for residents of New Hampshire and \$95.00 per credit for non-residents of New Hampshire. Graduate students registering for courses at the 400, 500, and 600 levels pay course charges at the rate of \$30.00 per credit for residents of New Hampshire and \$60.00 per credit for non-residents of New Hampshire. A student's eligibility for New Hampshire residency will be determined on the basis of the information submitted as part of the application. See page 146 for a complete statement of the University's regulations regarding eligibility for classification as a New Hampshire resident for tuition purposes.

The above charges will apply to admitted graduate students enrolling for courses at the University at Durham during the academic year. Graduate students planning to enroll for courses at the Merrimack Valley Branch, through

## Thesis and In Absentia Fees



the School of Continuing Studies, or during the summer session, should consult the relevant catalogs for information regarding fees.

**Master's Students:** Master's students registering for thesis credits (899) will pay by the credit until they have registered for the number of thesis credits permitted in their specific program. Master's students who have registered for the required number of thesis credits and are on campus completing their theses will pay a *Continuing Enrollment Fee* of \$100.00 per semester.

Master's students who are not registered for on-campus work at the time they complete their degree requirements (i.e., examinations, theses) will be assessed an *In Absentia Fee* of \$25.00 one month prior to the conferral of their degree. This fee will not apply to students removing course incompletes.

**Doctoral Students:** Doctoral students who are in residence and engaged in dissertation research must register for Doctoral Research (999) for a minimum of two semesters. The fee for this registration will be \$300.00 per semester or \$150.00 per summer session.

Doctoral candidates not working on the campus at the time they complete their degree requirements (i.e., examinations, submission of dissertation) will be assessed an *In Absentia Fee* of \$100.00 one month prior to the conferral of their degree.

A Memorial Union Fee of \$12.50 per semester and a student-services fee of \$5 per semester must be paid by all admitted students.

Students may audit courses with the consent of their adviser and the instructor involved. *Regular fees will be charged for all audits.*

University supported graduate assistants receiving the full stipend may be exempted from the payment of course charges and academic fees during the academic year of their appointment and the following summer session. University supported graduate assistants receiving half the normal stipend may be exempted from the payment of half of their course charges and academic fees in the academic year of their appointment and the following summer session.

**Refund of Course Charges:** Three-fourths of the course charges will be refunded to a student withdrawing during the first four days of a semester, one-half after four days and within thirty, and none thereafter. Admitted graduate students, at present, receive their course charge bills approximately four weeks after registration. Students should be aware that even though they withdraw before receiving a course charge bill, their liability for course charges is governed by the above regulation.

The University reserves the right to adjust rates for course charges and fees. Such adjustments will be announced as far in advance as possible.



# Financial Aid

## Assistantships and Fellowships



Approximately 300 graduate assistantships are awarded annually to superior students; appointments are for one academic year but may be renewable. These appointments involve half-time employment. The normal load for students holding appointments is three full courses per semester, or master's thesis, or doctoral research. All graduate students holding appointments as graduate or project assistants must be regularly admitted to the Graduate School and must be full-time students (i.e., registered for two or more full courses or equivalent thesis credits or doctoral research) during each semester in which they hold their appointments.

Appointments are made in the following categories:

**Graduate Assistants:** Most assistants are involved in assisting faculty members in instructional activities. A limited number of appointments involve assisting in research activities in the Agricultural Experiment Station. Stipends for first and second year graduate assistants are \$3000 per academic year. For students serving beyond two years as graduate assistants the stipend is \$3200 per academic year. Assistantships may include a waiver of tuition and academic fees for the academic year and the following summer upon recommendation of the department chairman and appropriate dean.

**Project Assistants:** An assistant who aids faculty members in an externally-funded research project. Stipends for project assistants are \$3850 per academic year. Project assistants do not receive a tuition waiver, but are charged tuition at the rate of \$42 per credit hour.

Full-time summer employment may be available for project assistants or graduate assistants. Assistants employed during the summer are paid up to \$560 per month for a maximum of two months full-time employment. Students so employed are not normally permitted to register for summer session courses.

Inquiries regarding assistantships should be addressed to the chairman of the appropriate department.

**Graduate Associates:** A very limited number of highly qualified graduate students may be appointed to teaching or research positions as graduate associates. The academic load for students appointed to these positions will not exceed one full course or doctoral research registration per semester. Stipends are negotiable up to \$5,000 per academic year according to the qualifications and duties of the student. Graduate associates whose positions are entirely funded from University funds may have one half of the dissertation fee or course charge waived (at the appropriate resident/non-resident rate) upon recommendation of the employing department. Graduate associates whose positions are funded externally (e.g., research) will be assessed the full dissertation fee and course charges.

**Summer Fellowships for Graduate Assistants:** A limited number of Summer Fellowships is available for students who have held graduate assistantships involving teaching during a previous academic year. The stipend for summer study is \$750.

**Tuition Scholarships:** Up to 50 superior students may be granted academic-year tuition scholarships. These awards provide only for waiver of tuition charges and are subject to the maintenance of a high scholastic record in the Graduate School.

Up to 30 superior students may be granted tuition scholarships for the summer session. Applications may be obtained from the dean of the Graduate School.

**University of New Hampshire Fellowships:** A limited number of three-year "University of New Hampshire Fellowships" is awarded to outstanding doctoral students. Each recipient is given an opportunity to spend the first year in full-time study, the second year as a teaching assistant, and the third year as a research assistant. The stipends for this program are \$3000 for the first academic year, \$3200 for the second academic year, and \$3400 for the third academic year. In addition, the award provides \$750 support for each of two summers, waiver of tuition, and an annual allotment of \$500 each for up to two qualified dependents. These awards are made by the Graduate School Student Fellowship Selection Committee from nominations from the various departments.

**Martin Luther King Assistantships:** Martin Luther King Assistantships provide support for qualified members of minority groups. Applications should be made to the dean of the Graduate School.

**Dissertation Fellowships:** Dissertation Fellowships with stipends of up to \$3000 for a maximum tenure of one academic year are available. These awards include a waiver of the doctoral research registration fee for the period of the award. Applications should be made to the dean of the Graduate School.

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## **Federally Funded Traineeships and Fellowships**

Subject to the availability of federal funds, a variety of federal fellowships and traineeships are available for outstanding graduate students. These awards are open to U.S. citizens only. The stipends for these awards vary somewhat but average \$3000 for 12 months of study plus tuition waiver.

Awards may be available for certain graduate programs in the departments of education, english, and sociology. Students should contact these departments directly concerning these awards.

Application for the following awards should be made to the offices noted:

**Public Health Service Traineeships and Fellowships:** Awards are made for study in health-related fields by the National Institutes of Health and other federal agencies. Applications should be made directly to Career Development

Review Branch, Division of Research Grants, National Institutes of Health, Public Health Service, Bethesda, Maryland 20014.

**National Science Foundation Graduate Fellowships:** Awarded to master's and doctoral students in the mathematical, physical, medical, biological, engineering, and social sciences, and in the history and philosophy of science. Applications should be made to the Fellowship Office, National Research Council, 2101 Constitution Avenue N.W., Washington, D.C. 20418.

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## Loan and Work-Study Programs

**National Defense Student Loans:** To be eligible for consideration, a student must be an admitted degree candidate carrying at least one half the full-time academic load as defined by the University; be a U.S. citizen or a permanent resident of the U.S.; establish need for a loan which is to be used for educational purposes only.

**UNH Loans:** To be eligible for consideration, a student must be an admitted degree candidate carrying at least one half the full-time academic load as defined by the University. Financial need must be clearly established, and if approved, the loan may be used for educational purposes only. The maximum amount granted to a student is \$1000 during his or her undergraduate and/or graduate work.

**College Work-Study Program:** With the aid of federal funds, the University is able to provide employment opportunities on campus or in various off-campus agencies. To be eligible for consideration, a student must be an admitted degree candidate carrying at least one half the full-time academic load as defined by the University, and demonstrate financial need as determined by the Financial Aid Office. Work during the academic year is usually on campus and may be up to 40 hours per week.

Applications for the above programs may be obtained from the Financial Aid Office, Thompson Hall, and must be returned not later than May 1.

**Guaranteed Student Loan Program:** Students may apply for as much as \$2500 per year from a bank or other financial institution participating in the Guaranteed Student Loan Program. Qualified borrowers pay no interest while attending college. Repayment of principal and interest begins nine months after the student ceases a full-time course of study. Check with your local bank for further details and current interest charges.

# Academic Regulations



When a student is admitted to the Graduate School, he will be assigned an adviser whose academic interests parallel those of the graduate student. Students will plan their programs in consultation with their advisers.

A student who wishes to pursue a degree or program other than that to which admission was granted should file an application for a change in degree with the Graduate School. The dean of the Graduate School will notify the student of his decision after consulting with the appropriate departments.

Master's candidates who intend to go on to the Ph.D. in the same department in which they were admitted for the master's degree should submit to the dean of the Graduate School an application for a change in degree program. This application will be reviewed by the dean of the Graduate School who will notify the student of the decision. A student who has received the master's degree before applying for admission to study for the Ph.D. degree will be required to submit a new application.

## Graduate Credits and Grades

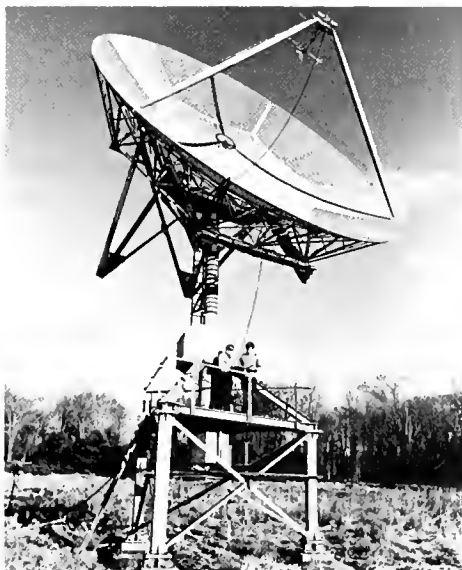


**Credits:** Graduate credits may be earned in courses numbered from 700 through 898, and in the thesis. Graduate credits will not be given for any courses so numbered which are open to freshmen and sophomores. Under certain conditions graduate credit may be allowed for 600-level courses in master's degree programs. (See general requirements for master's degrees.)

Upon recommendation of the department, superior senior students may petition the Graduate School to be allowed to count credits for up to two 800-level courses toward both a bachelor's and master's degree, provided the student has been admitted to the master's program before enrolling in the courses. (See admission requirements for UNH seniors.)

In some departments or programs it is possible for students to do a part of their work during the summer session or in the Division of Continuing Education. Students should consult the Summer Session or Division of Continuing Education offices in Verrette House concerning the courses offered and course schedules. Students intending to graduate in September, 1975, must present dissertation or thesis to the Graduate School Office by August 15; the last day for final Ph.D. and master's examinations and completion of all degree requirements is August 22.

**Grades:** The following grades are used in the University: A, A-, B+, B, B-, C+, C, C-, D+, D, D-, F. Graduate credit is normally granted only for course work completed with a grade of B- or higher. Any grade below the B- level will normally not count for graduate credit and will count toward the accumulation of nine failing credits which will normally result in a student being required to withdraw from the Graduate School.



However, a student's advisory committee, or his/her adviser and appropriate departmental committee, may recommend to the dean of the Graduate School that up to eight credits of C or C+ be granted for graduate credit. When a student's advisory committee or his/her adviser in conjunction with the appropriate departmental committee wishes to recommend that credit be given for work completed with a C or C+, the advisory committee shall forward their recommendation with the appropriate justification within one month of the conclusion of the course.

A grade of Credit (Cr.) will be given for complete and approved theses and dissertations.

With the permission of the instructor at the time of registration, a graduate student may elect to take independent study courses on a credit/fail basis. Students electing this option should ask the instructor to send written notification to the Graduate School and Registrar's Office that the graduate student is taking the course credit/fail.

An incomplete grade earned by a graduate student must be removed by the end of the semester following the one in which the incomplete grade was obtained. An incomplete grade automatically becomes an "F" if not removed within the allowed time period. The burden of removing the incomplete grade rests with the student. This rule does not apply to the completion of the thesis.

## Requirements for Master's Degree



**General Requirements:** For the degrees of Master of Arts, Master of Science, Master of Occupational Education, Master of Business Administration, and Master of Public Administration, at least 30 credits must be earned, including a minimum of eight credits, not including thesis, in courses numbered 800-898. Courses numbered 600-699 cannot be used towards these master's degrees if the courses are given in the department awarding the degree. No more than 12 credits will be permitted in courses numbered 600-699. The major department will prescribe for its students the courses which make up the degree program. Somewhat different requirements obtain for the Master of Science for Teachers degree and it is recommended for this degree, as well as for all other master's degrees, that the appropriate departmental section of the catalog be consulted.

A student will normally spend at least one calendar year, or the equivalent, in satisfying the requirements for the degree. No more than 12 credits, not including thesis, may be earned off the Durham campus. A student may present for credit a maximum of six credits earned at another graduate school, provided that these credits are of a grade of at least B or the equivalent. Credits from another graduate school will count as part of the 12 credits which may be earned off the Durham campus. These credits will be applied toward the degree only if



recommended by the major department and approved by the dean of the Graduate School.

All graduate work for any master's degree must be completed in not more than six years from the time of registration for the first graduate work applied toward the degree. Progress toward the degree will be carefully monitored by the adviser and the Graduate School to ensure that adequate progress is made toward the completion of the program, and that any deficiencies noted at the time of admission are removed.

In any department or program requiring a final examination for the master's degree, the examination may be oral, written, or both. A candidate will be permitted only two opportunities to take the final examinations for the master's degree, and the time of these examinations will be at the convenience of the department concerned, except that all such examinations must be given at least two weeks before the Commencement date in the year in which the degree is to be conferred. Further regulations governing the final written examination, when required, will be made by the department concerned, subject to the approval of the dean of the Graduate School. Oral examining committees, when required and not otherwise provided for, are appointed by the dean of the Graduate School, upon the recommendation of the department concerned. The graduate dean is, ex officio, a member of all examining committees.

**Master's Thesis:** A thesis may be required of candidates for the Master of Arts or the Master of Science degrees. Consult the departmental statement for thesis requirements. The thesis must be approved by a committee, comprising the instructor under whose direction it was written and two other members of the graduate faculty nominated by the department chairman and approved by the dean of the Graduate School.

Each department will determine the date when the candidate must submit for approval a statement of the subject of the thesis and the date when the thesis must be completed.

From six to ten thesis credits may be applied toward a master's degree, subject to the approval of the student's adviser. No thesis credit shall be given until the completed thesis has been approved by the thesis committee. No letter grade shall be given for the thesis, but its satisfactory acceptance will be recorded with a CR (credit).

The student should obtain from the Graduate School Office the latest regulations for the form and typing of theses.

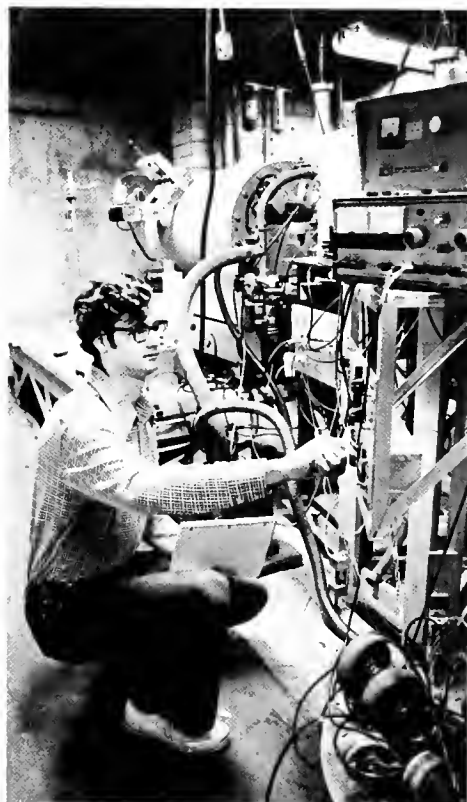
Whenever a thesis is published or otherwise reproduced, it must be designated as having been accepted as a master's thesis by the University of New Hampshire.



Two copies of the approved thesis, ready for binding, shall be submitted to the Graduate School Office as soon after approval as possible but not less than one week before Commencement, together with a receipt for the binding fee from the University Bookstore. Most departments require one copy of the thesis in addition to the above-mentioned two copies. Students should consult their advisers concerning these requirements.

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## Requirements for Doctor's Degrees



**General Requirements:** The degree of Doctor of Philosophy is conferred on qualified candidates who have passed an oral or written examination on the subject matter of their field of study, who have completed an original investigation in this field and have embodied the results in an acceptable dissertation, and who have passed an oral examination in defense of the dissertation. The degree of Doctor of Philosophy is essentially a research degree. It is not given merely for the completion of course credits. Graduate programs leading to the degree of Doctor of Philosophy are offered in biochemistry, botany, chemistry, economics, english, engineering, genetics, history, mathematics, mathematics education, microbiology, physics, plant science, psychology, sociology, and zoology.

All resident predoctoral students must register each semester until requirements for the degree have been completed. The minimum requirement for the doctorate is three years beyond the bachelor's degree. Resident graduate work done at other universities may be counted toward the minimum requirement upon approval of the guidance committee and the dean of the Graduate School, but one full academic year must be in residence at the University of New Hampshire. In individual cases, the major department and the dean of the Graduate School may grant permission to pursue the research for the dissertation at another institution where access to special facilities is advantageous.

All graduate work for the doctorate must be completed by the end of the fifth academic year following that in which the student completes the requirements for advancement to candidacy.

**Degree Candidacy:** A guidance committee will be appointed by the dean of the Graduate School upon the recommendation of the department as soon as possible after a student has begun study for the doctoral degree. The committee will have the responsibility of assisting the student in outlining a program, and preparing for and administering the qualifying examination.

The qualifying examination may be written, oral, or both. This examination will test: 1) the student's general knowledge in the student's major and minor work and 2) the student's fitness for engaging in research, particularly in the subject proposed for the dissertation. The results of the examination will be



communicated by the chairman of the major department to the dean of the Graduate School.

After the successful completion of the qualifying examination, a doctoral committee will be appointed to supervise and pass on the dissertation and administer the final examination. This committee will be nominated by the department of major concentration and appointed by the dean of the Graduate School. It shall consist of a minimum of five members, usually three from the major department and two from related departments. The dean of the Graduate School is an ex officio member of all doctoral committees.

The student may not be advanced to candidacy for the Ph.D. until the qualifying examination has been passed and such language or proficiency requirements as are deemed desirable by the major department have been met. The proposed subject of the student's dissertation must be declared at the time of advancement to candidacy.

**Dissertation:** The dissertation must be a contribution to scholarship in the student's discipline, embodying the results of significant and original research, and a mature and competent piece of writing.

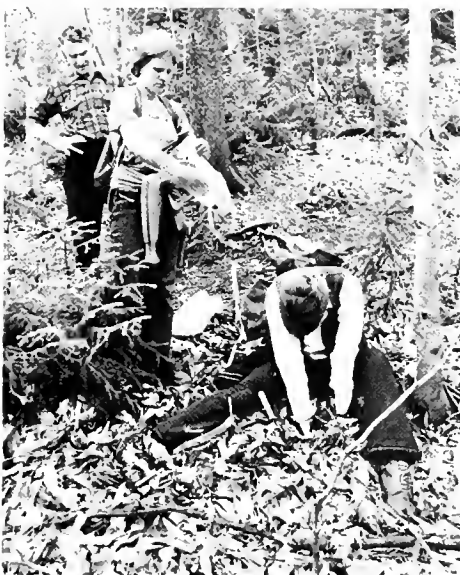
A copy of the completed dissertation must be made available to the dean of the Graduate School and to the members of the examining committee two weeks before the final examination date. As soon after the examination as possible but not less than one week prior to Commencement, two copies of the approved dissertation, ready for binding, shall be turned in to the Graduate Office, together with a receipt for the binding fee from the University Bookstore.

Publication of the dissertation by University Microfilms will be required, and the cost will be assumed by the student. If the material presented in the dissertation is published, it should be designated as having been accepted as a doctoral dissertation by the University of New Hampshire.

The final oral examination is conducted by the doctoral committee and is intended to give the candidate an opportunity to defend his dissertation. A written final examination, on subject matter not covered in the qualifying examination, may also be required. This written examination is conducted by the major department. These final examinations must be completed at least two weeks prior to the date of receiving the degree. After consultation with the major department, the dean may appoint, for participation in the final oral examination, additional members of the faculty under whom the student has worked. The doctoral committee alone shall decide on the merits of the candidate's performance by a majority vote.



## Registration Procedure



Students admitted to the Graduate School must have programs approved by the chairman of the department or the chairman of the guidance committee and by the dean of the Graduate School. Registration is held prior to the beginning of classes each semester, and on the first day of the summer session. Consult the calendar in this catalog for the date of registration. Preregistration is mandatory for all students other than newly admitted students, and takes place at the Registrar's Office approximately six weeks prior to the end of each semester. A \$10 fee is charged for not preregistering. Registration information and Time and Room schedules may be obtained from the Registrar's Office, Thompson Hall.

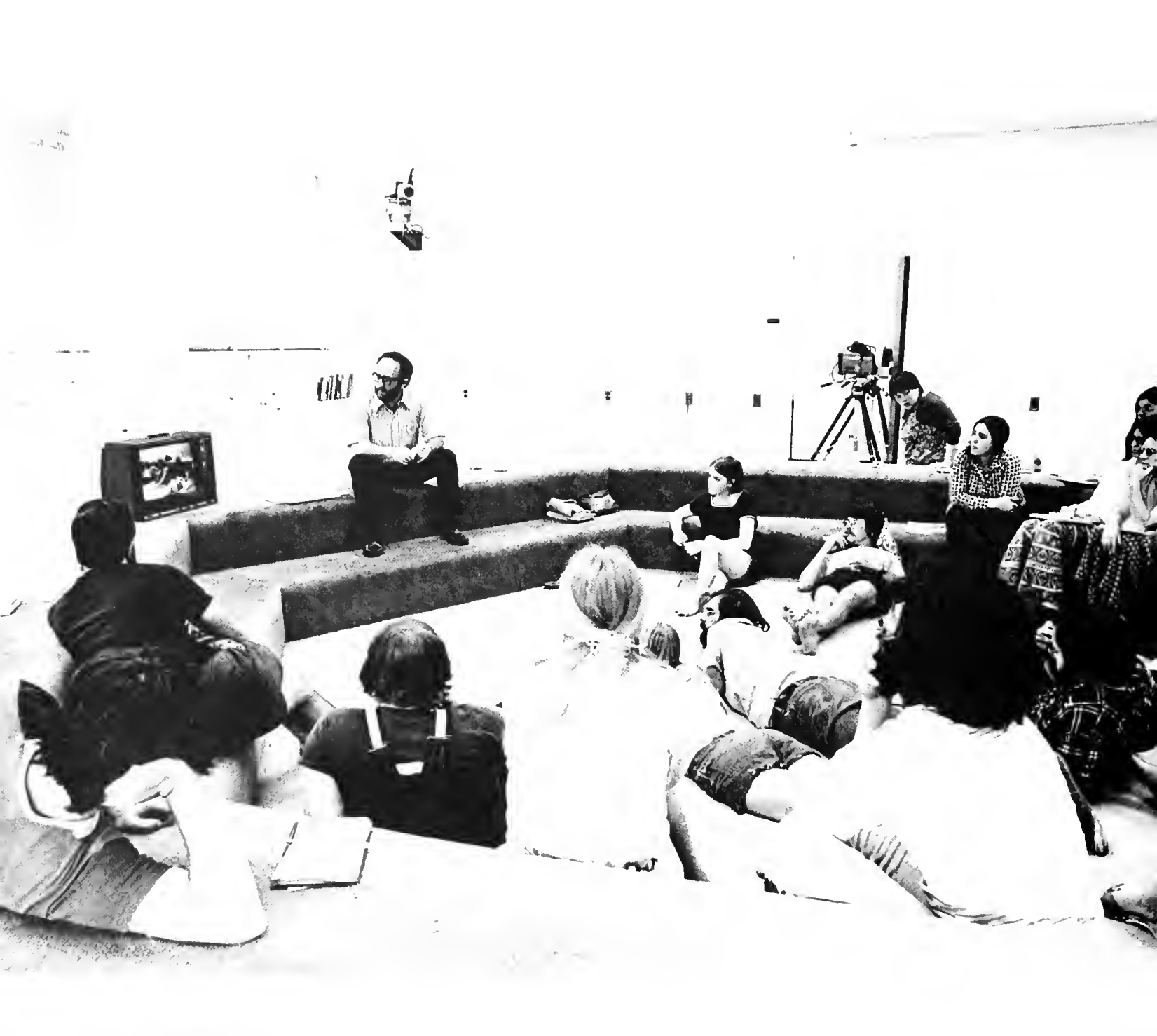
Students who find it necessary to interrupt their graduate programs may request a leave of absence by writing to the dean of the Graduate School stating the reasons for and the anticipated length of the interruption.

Students who do not register during a twelve-month period and have not notified the Graduate School of their intention to continue in their degree programs must reapply for admission in order to resume their graduate work.

**Withdrawal Procedure:** A student may withdraw from the Graduate School during any semester by obtaining a withdrawal form from the Registrar. This form should be signed by the student's adviser, the dean of the Graduate School, and other appropriate University officials (e.g., the director of residences). When completed, the form should be filed with the Registrar.

**Full-time Graduate Students:** Full-time graduate students are those students who have received either a conditional or regular admission and are enrolled for a minimum of two full courses, or equivalent thesis credits, or doctoral research registration.

The maximum graduate load allowed is sixteen credits for a regular semester, four credits for a four-week summer session, and eight credits for an eight-week summer session. Only under unusual circumstances will a student be allowed to exceed these limits, and then only with the recommendation of the student's adviser and the approval of the dean of the Graduate School.



# UNH and Graduate Life

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The University is located in Durham—one of the oldest towns in northern New England. Durham is a small town located in a semi-rural area which still retains abundant traces of its colonial past. Easy accessibility to Boston's cultural opportunities (90 minutes to the south); the unsurpassed skiing, hiking, and scenery of the White Mountains (90 minutes northwest); and sandy beaches and rocky coast of New Hampshire and Maine (30 minutes east) make it an ideal location.

The University campus (156 acres in size) is surrounded by more than 3,000 acres of fields, farms, and woodlands owned by the University. An impressive building program has resulted in 35 buildings for teaching, research, and administration, and 21 residence halls for men and women. The beauty of the campus is enhanced by a stream flowing through a large natural area in the middle of the campus.

The Durham campus is composed of the College of Liberal Arts, College of Life Sciences and Agriculture, College of Technology, Whittemore School of Business and Economics, School of Health Studies, Thompson School of Applied Science, Division of Continuing Education, and the Graduate School. In addition to the colleges and schools on the University campus at Durham, the University System of New Hampshire includes Keene State College, Plymouth State College, and the Merrimack Valley Branch at Manchester. The School of Continuing Studies makes educational opportunities available throughout the state.

The University enrolls more than 10,000 students, has a full-time faculty of more than 500, and offers 80 undergraduate and 39 graduate programs. The student body includes 1000 graduate students taught by a faculty of over 400.

The University of New Hampshire is one of 117 colleges made possible by federal land grants which aided states in developing institutions to serve all the people. The institution was founded as New Hampshire College of Agriculture and Mechanic Arts in 1866 to train young men and women for service to the state through agriculture and technology. In 1893, New Hampshire College (as it was called at that time) moved from Hanover to Durham as the result of a bequest of lands and funds by Benjamin Thompson, and developed more rapidly. University status was conferred in 1923.

## Graduate Student Life

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Graduate students play an active role in the life of the University community. In most departments, students are consulted concerning issues affecting their programs, and serve as full voting members on important departmental committees. Three graduate students are elected by the graduate student organiza-





tion as full voting members of the Graduate Council—the body which advises the graduate dean on all matters concerning Graduate School policy. Five graduate students, elected by districts, serve in the University Senate, which is the primary governing body in matters of undergraduate student conduct and academic decisions. Graduate students serve on such University-wide committees as the Research Council, the Teaching and Learning Council, and the University Academic Planning Committee.

Babcock House, the graduate student residence hall, has become an increasingly active center for both academic and non-academic graduate student activities. Events in the past year have included seminars on job opportunities, art exhibits, film series, evening gatherings; fishing trips, and trips to “Boston Pops” concerts. Most events at Babcock House are open to all graduate students. Graduate students are invited to participate in most undergraduate clubs and social organizations.

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## **Recreation and Cultural Activities**

Graduate students may participate in a variety of recreational, social, and cultural programs that take place on the campus throughout the year.

The programs and services are coordinated by the Office of Recreation and Student Activities, located in the Memorial Union.

Services include a reception area—visitors’ information center, the University Ticket Office, and a scheduling office for room and facility reservations. An optional recreation pass may be purchased individually and for families.

Recreational activities are organized in three interrelated programs: men’s and women’s intramural sports, club sports, and leisure-time activities.

Men’s intramurals range from golf, tennis, and touch football in the fall to ice hockey and water polo in the winter, and cycling and soccer in the spring. Women’s intramurals include powder-puff football, badminton, basketball, bowling, soccer, softball, and tennis.

The club sports program offers instruction as well as competition with other college clubs in New England. Rugby, sailing, trap and skeet, and water polo are among the 26 club sports.

Informal participation in swimming, exercising and jogging, tennis, ice skating, gymnastics, and field sports is available at Mendums Pond, Snively Arena, and the Field House.

Student organizations bring folk and rock concerts to campus and provide a wide variety of social events including dances and gourmet dinners. The Memorial Union houses the student-operated AM-FM radio station, the student newspaper, and offices for student organizations, and provides facilities for student film services.

The Sidore Series brings provocative, well-known speakers and experimental programs throughout the year. The Blue and White Series is host to leading concert artists, and the Allied Arts Series provides a varied program of drama, music, and dance.

University students perform frequently in concerts, recitals, and theatrical productions. These programs originate in the music, and speech and drama departments and are open for participation to graduate students. The Department of the Arts hosts exhibitions in the newly redesigned University Galleries. The University's two theaters and the art galleries are located in the Paul Creative Arts Center.

The University Library has music listening rooms and a collection of more than 5,500 tapes and records. New Hampshire's educational television station, WENH-TV, broadcasts in-school programs for 110,000 young people, and, during evening hours, cultural and educational programs. Students may work at the station on a volunteer basis.

## Student Services

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### Graduate School Office

The Graduate School office is available to assist graduate students in both academic and personal matters affecting their study at the University. The staff will assist graduate students with information and advice concerning such academic issues as admission, degree requirements, thesis and dissertation format, procedures for changing programs, interdisciplinary options, availability of fellowships and other forms of financial aid (both UNH and external), and part-time employment opportunities. The Graduate School supports graduate student organizations, and assists in planning social, informational, and academic programs and events for both graduate students and faculty. Students are urged to contact the office concerning any questions which may arise concerning the availability or applicability of various University sponsored student services to graduate students.

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### Graduate Student Residences

**Off-Campus Housing:** The Residence Office operates an office to assist students in obtaining off-campus housing. As in most university communities, rents in the Durham area can be high and the supply limited. The office does have listings of off-campus rentals in Durham and the surrounding area which are updated weekly.

Students are encouraged to make every effort to come to campus so that the Off-Campus Housing Office will be able to assist in finding accommodations. The Off-Campus Housing Office is located in Stoke Hall, open Monday through Friday.



**Forest Park Apartments:** The University owns and operates Forest Park, a complex of 154 studio (efficiency), one-, and two-bedroom apartments for students, faculty, and staff with families. The development is composed of two and three story buildings located on the edge of campus, convenient to all University facilities and within walking distance of Durham shopping and school facilities. Residency is not limited to graduate student families, and the demand for these apartments is great. To be eligible for the University apartments, a graduate student must have been admitted to the University and be a full-time student as defined in this catalog. Students may apply for Forest Park before fulfilling the above requirements as long as they are met at the time of assignment.

Since the waiting time can approach one year from date of receipt of application until assignment, students should apply as early as possible. A brochure containing the application blank and information concerning Forest Park is available upon request. Contact Forest Park Resident Manager, Apartment 11B, Forest Park, Durham, N.H. 03824.

**Babcock House:** The graduate residence is designed to provide housing for single, full-time graduate students; and to provide quiet, dignified areas for graduate students to meet informally with one another and with members of the faculty.

Babcock House is located on McDaniel Drive within easy walking distance of a number of major classroom areas as well as the University Library, University Theater, and the Memorial Union Building. For those students with cars, parking is provided in areas convenient to the building.

The structure consists of two six-story towers, connected at each floor by a common lounge and accommodates 180 men and women. The House has a large lounge with fireplace, two recreation rooms, a food-vending room, coin-operated laundry, TV room, luggage storage, individual mail boxes, and private room-telephones, if desired. The rooms are all single rooms allowing complete privacy for consultation with students or faculty; and each is furnished with a bed, mattress, easy chair, desk chair, and built-in desk-dresser-wardrobe unit with book shelves, mirror, medicine chest, and desk lamp. The rental charge for Babcock House is \$730 per student per academic year, subject to revision by the Board of Trustees.

A faculty resident and family live in a two-bedroom apartment on the ground floor. The faculty resident works with the House Council, composed of all graduate students planning cultural and social programs, and with individual students on a personal level.







The faculty resident, with the aid of two graduate resident assistants, carries out the administrative responsibilities of the house and is knowledgeable about University policies and available personal services.

Residents provide their own bedding. An optional linen service is available which furnishes bed linen, towels, and blankets at a minimal cost.

Following acceptance to the Graduate School, a student interested in Babcock residence must return a completed Room and Board Agreement Card with \$50 prepayment to: Graduate Residence, c/o Residence Office, 7 Stoke Hall, UNH, Durham, N.H. 03824. There are usually more applicants than there are spaces available, so it is important that a student return the application and prepayment promptly. A waiting list is maintained for applicants whom it is impossible to house immediately.

**Summer Housing:** A limited number of rooms in Babcock House are available to graduate students taking courses during the summer. Students interested in summer accommodations should contact the Summer Housing Office, University of New Hampshire, Durham, N.H. 03824.

## Dining

Graduate students may elect to take their meals on a contractual basis with the University Dining Halls whether or not they live on campus. These meal tickets may be used in any of the three dining halls. There are limited cooking facilities in Babcock House; none are available in individual rooms.

## Counseling and Health Services



**University Health Service:** This service, located in Hood House, contains a well-equipped outpatient clinic for initial diagnosis and treatment of student health problems. Services include: out- and in-patient care, laboratory tests, x-rays, limited mental health care, and routine medications. For serious medical problems students are generally referred to consultants and/or a local hospital. An emergency ambulance service is available.

During the regular academic year, Hood House is staffed by full-time physicians, nurses, and part-time consultants. Regular clinic hours are held and appointments may be made upon request. Nurses are available twenty-four hours a day and a duty doctor is always "on call."

Hood House is closed during holidays and semester breaks and operates on a very limited basis during summer session. The spouse and children of students and University employees are not eligible for treatment at Hood House.

As a supplement to the Health Service program, an optional group accident and sickness insurance is available through the University Business Office.

**Counseling and Testing Center:** This agency, in collaboration with the Student Health Service at Hood House, is the primary mental health facility on campus. The center provides without charge, and through a professional staff, coun-

seling to students who are experiencing personal difficulties or some disruption in their academic lives. Its services, which include individual and group counseling, are designed primarily to meet the typical needs of students who seek more personal and academic effectiveness.

The full- and part-time staff includes seven psychologists, two clinical associates, and six interns. A consulting psychiatrist is available for students whose needs go beyond the scope of the center's facilities. Individual testing is also available to help students establish goals, sort out their strengths and weaknesses, and assist in academic and career planning.

All information about students' visits to the center is confidential and is not released without permission.

During vacations and the summer, the center is only open on a limited basis.

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## **Career Planning and Placement Service**

This service helps students to obtain permanent employment upon graduation from the University. The services are available to students completing degree requirements and to alumni who have received degrees from the University in Durham. The Career Planning and Placement Service is located in Room 203 of Huddleston Hall.

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## **Campus Minister and Churches**

The Ecumenical Ministry to the University of New Hampshire is a cooperative endeavor involving a full-time on-campus minister; concerned administrators, faculty, and students; the designated denominational chaplains; and Durham residents. The Ecumenical Ministry focuses on issue-oriented programs, teaching, involvement in the needs and concerns of various members in the University, and counseling. In addition, there are specific organizations such as Hillel for Jewish students, the Inter-Varsity Christian Fellowship, the Fellowship of Christian Athletes, the Christian Science and Latter Day Saints groups and the Durham Unitarian Universalist Fellowship, which provides religious activities. In Dover are the Greek Orthodox Church and a Friends Meeting; Protestant, Catholic, and Episcopal churches are located in Durham.

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## **The Alumni Association**

All recipients of a graduate degree from the University are considered members of the Alumni Association. It organizes alumni activities including social and educational programs both on and off the campus. *The New Hampshire Alumnus* contains news of alumni, the University, students, and faculty. Some departments also inform their alumni on a regular basis.



# Departmental Requirements and Course Descriptions

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## Course Guide

The title and the Arabic numeral designate the particular course. Odd numerals indicate courses normally offered in the first semester; even numerals indicate courses normally offered in the second semester. Course numbers enclosed by parentheses indicate the course is offered out of sequence. If the course numerals are connected by a hyphen, the first semester, or its equivalent, is a prerequisite to the second semester. If the numerals are separated by a comma, properly qualified students may take the second semester without having had the first. Cr/F following the description indicates that the course carries no letter grade, being marked "Cr" for credit, "F" for failure.

## Animal Sciences (17)

**Chairman:** W.C. Skoglund

**PROFESSORS:** Fred E. Allen, Walter M. Collins, William R. Dunlop, Richard C. Ringrose, Winthrop C. Skoglund, Samuel C. Smith, Richard G. Strout

**ASSOCIATE PROFESSORS:** Allan C. Corbett, Thomas P. Fairchild, James B. Holter, Gerald L. Smith, Larry L. Stackhouse

**ASSISTANT PROFESSORS:** Frank Repka, Edward Squires, Thomas Wight

**LECTURERS:** Elizabeth Smith, James T. O'Connor Jr.

To be admitted to graduate study in animal sciences, an applicant is expected to have had sufficient undergraduate training in the basic biological sciences to qualify for special work in this field. The M.S. degree is offered in the areas of genetics, nutrition, physiology, diseases and parasites, and management. A thesis is required, and a candidate for the master's degree shall pass an oral examination covering the graduate courses and thesis. We encourage all students to obtain teaching as well as research experience during their graduate study.

### 701. PHYSIOLOGY OF REPRODUCTION

Physiology, embryology, endocrinology, reproduction, and lactation in domestic animals. Mr. Strout, Mr. Stackhouse. 3 lec/1 lab/4 cr.

### 705. A REVIEW OF ANIMAL SCIENCE

The principles and practices relating to the feeding, breeding, selection, and management of beef cattle, horses, sheep, and swine. For teachers of vocational agriculture and other students with the permission of their advisers. Staff. (Summer Session only.) Two hours daily, lecture and laboratory; 2 cr.

### 706. A REVIEW OF DAIRY SCIENCE

Subject matter covering the principles and practices relating to the latest information on dairy cattle breeding, feeding, and management, and the processing and marketing of milk and its products. For teachers of vocational agriculture and other students with the permission of their advisers. Staff. (Summer Session only.) Two hours daily, lecture and laboratory; 2 cr.

### 707. A REVIEW OF POULTRY SCIENCE

The principles and practices relating to the latest information on poultry breeding, feeding, diseases, and management. For teachers of vocational agriculture and other students with the permission of their advisers. Staff. (Summer Session only.) Two hours daily, lecture and laboratory; 2 cr.

### 709. BIOCHEMISTRY OF NUTRITION

Intermediary metabolism of nutrients and energy; metabolism transport mechanisms; biological oxidation; interrelationships of carbohydrate, fat, and protein metabolism; obesity; control of hunger and appetite. (Also offered as Home Ec. 709.) Mr. Repka. 3 lec/1 lab/4 cr.

### 710. RUMINANT NUTRITION

Feeding and management of dairy animals; calf feeding, raising young stock, feeding for economical milk production. Mr. Holter. 3 lec/1 lab/4 cr.

### 711. COMPARATIVE ANIMAL GENETICS

How heredity affects domestic animals, poultry, other mammals, and fish; emphasis on the organism and population. Quantitative inheritance, principles of selection, disease resistance, also studied. Statistical and experimental techniques. Prerequisite: 4 cr. of genetics or permission of instructor. Mr. Collins. 3 lec/1 lab/4 cr.

### 712. ANIMAL BREEDING AND IMPROVEMENT

Population genetics and selection in dairy cattle, livestock, and horses. Prerequisite: A.S. 711. Mr. Fairchild. 3 lec/1 lab/4 cr. (Alternate years; offered 1975-76.)

### 713. INTRODUCTION TO ELECTRON MICROSCOPY

A detailed consideration of the principles and methods used in preparing and examining vertebrate, invertebrate, microbial, plant and physical specimens in the electron microscope. Topics include the theory and application of fixation and embedding procedures, ultramicrotomy, operation of the electron microscope and special techniques such as autoradiography and ultrastructural histochemistry. Mr. Wight. Prerequisite: General Chemistry. 3 lec/1 lab/4 cr.

## 795-796. INVESTIGATIONS IN DAIRY, LIVESTOCK, POULTRY

- 1) **Genetics:** Mr. G.L. Smith, Mr. Collins, Mr. Fairchild.
- 2) **Nutrition:** Mr. G.L. Smith, Mr. Ringrose, Mr. Holter, Mr. Repka.
- 3) **Management:** Mr. G.L. Smith, Mr. Skoglund, Mr. O'Connor.
- 4) **Diseases:** Mr. Allen, Mr. Corbett, Mr. Dunlop, Mr. Strout, Mr. S.C. Smith, Mr. Stackhouse, Mr. Wight.
- 5) **Products:** Mr. G.L. Smith.
- 6) **Light Horses:** Mr. O'Connor, Ms. Briggs, Mr. Squires.
- 7) **Physiology:** Mr. Squires.

An opportunity is given for the student to select a special problem in any of the fields listed under the guidance of the instructor. Elective only after consultation with the instructor in charge. May be repeated. 1-4 cr.

## 801. ADVANCED STUDIES IN ANIMAL BREEDING

Independent study and research on modern breeding methods and newer systems of selection for quantitative traits. Prerequisite: Animal Science 712. Mr. Collins, Mr. Fairchild, Mr. G.L. Smith. Hours to be arranged. 3 cr.

## 802. MEATS, LIVESTOCK MARKETS, AND PRODUCTS

The essential factors in meat selection, cutting, curing and smoking; study and discussion relative to the problems of livestock marketing and the procedure in the large central markets. Trips are taken to various packing plants. Mr. Gerald Smith. 3 lec/1 lab/4 cr.

## 803. ENERGY METABOLISM AND NUTRITION

Incidental lectures, assigned reading, and laboratory practice in methods of research with major emphasis on protein and energy metabolism. Mr. Holter. 3 cr. (Alternate years; offered in 1976-77.)

## 805-806. AVIAN MICROBIOLOGY

The disease process (acute or chronic) in the intact host at cellular levels when invaded by viruses or virus-like agents, fungi, and protozoans. Physiological and cytopathological changes in tissue culture. Mr. Dunlop, Mr. Strout, and Mr. Corbett. Prerequisite: Animal Science 612 or the equivalent. 3 cr.

## 807-808. AVIAN HISTOPATHOLOGY

First semester: general histopathology. Second semester: the special histopathology of common diseases with emphasis on correlation of light and electron microscopy of tumors and tumor formation. Mr. Dunlop and Mr. Strout. Prerequisite: histology or the equivalent. 3 cr.

## 809. ADVANCED POULTRY NUTRITION

Metabolism and the physiology of digestion with emphasis on nutrient needs and deficiency diseases of poultry. Analysis of recent experimental research and current feed problems. Mr. Ringrose. 3 cr.

## 810. BIOCHEMICAL CO-FACTORS

Designed to provide the student with an understanding of the significant role of the vitamins and trace minerals in metabolism in man and animals. Mr. Ringrose. 2 lec/1 lab/4 cr.

## 812. QUANTITATIVE GENETICS AND SELECTION

Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, correlated characters. Mr. Collins. Prerequisite: 1 course each in genetics and statistics. 3 cr. (Alternate years; offered in 1975-76.)

## 851. CELL CULTURE

Theory, principles fundamental to the culture cells in vitro. Introduction to techniques of preparation, maintenance of animal, plant, insect, fish cell cultures. Application of cell culture to contemporary research in biological sciences. Prerequisite: Microbiology 503 and permission of instructor. (Also offered as Microbiology 851.) 2 lec/lab/4 cr.

## 852. ADVANCED CELL BIOLOGY

A study of the ultrastructure and function of cell organelles followed by an analysis of various specialized animal cells to show how differences in form and location of various organelles lead to differences in function. Mr. Wight. Prerequisite: biochemistry, physiology, and vertebrate anatomy or permission of instructor. 3 lec/4 cr.

## 897-898. ANIMAL SCIENCE SEMINAR

A survey of recent literature and research in the animal sciences. Staff. 1 cr. May be repeated.

## 899. THESIS

Hours and credits, from 6-10, to be arranged.

# Biochemistry (18)

**Chairman:** Gerald L. Klippenstein

**PROFESSORS:** Donald M. Green, Edward J. Herbst, Miyoshi Ikawa, Samuel C. Smith, Arthur E. Teeri

**ASSOCIATE PROFESSORS:** Gerald L. Klippenstein, James A. Stewart

# Biochemistry

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For admission to graduate study in biochemistry an applicant is expected to have completed basic courses in chemistry, biological sciences, mathematics, and physics. Otherwise well qualified applicants will be permitted to correct deficiencies in undergraduate education by enrollment in the appropriate courses or by independent study.

The department offers opportunities for specialization in developmental biochemistry, biochemistry of natural products, physical biochemistry, biochemical genetics, and structure and metabolism of macromolecules. Opportunities also exist for interdisciplinary research specialization in marine biochemistry and cell biology in adjunct facilities on campus and at the Jackson Estuarine Laboratory. In addition to the graduate courses in biochemistry, courses in advanced organic chemistry, radiochemistry, physiology, advanced microbiology, and genetics are usually recommended.

Participation of all graduate students will be required in the instructional activities of the department, either in the laboratory, in lectures or in an individual instruction format. These teaching assignments are an essential part of the graduate academic programs of the department and are designed to give graduate students practical teaching experience.

A Master of Science degree candidate will be expected to develop a thesis on a basic research problem or to prepare a report or publication based on an applied project in biochemistry. All candidates for the M.S. degree will be required to pass an oral examination based on the thesis or project report and on the graduate courses completed in the degree program.

The Doctor of Philosophy degree candidate will be required to complete a dissertation on original research in biochemistry. At the end of the first year of graduate study, a Preliminary Examination on organic chemistry, physical chemistry, and general biochemistry will be presented to students in the doctoral program. The results of this examination and the student's academic record will be evaluated at this time to ascertain eligibility to proceed to candidacy in the doctoral program. Upon completion of graduate courses recommended by a guidance committee and demonstration of proficiency in the translation of biochemical literature in either German, French, or Russian, a doctoral student will be required to pass an oral qualifying examination conducted by the guidance committee. The successful completion of these requirements and advancement to candidacy for the Ph.D. degree must occur at least six months prior to the final oral defense of the Ph.D. dissertation administered by the student's doctoral committee.

## 601. GENERAL BIOCHEMISTRY

The general principles. Mr. Ikawa. Prerequisite: organic chemistry. Students receiving credit for Biochem. 601 may not receive credit for Biochem. 501. 3 lec/1 lab/4 cr.

## 656. PHYSIOLOGICAL CHEMISTRY AND NUTRITION

Mammalian biochemistry with emphasis on the human. Lab study includes procedures basic to chemical methods of medical diagnosis. Mr. Teeri. Prerequisite: organic chemistry. 3 lec/1 lab/4 cr.

## 702. COMPARATIVE MARINE BIOCHEMISTRY

Nutrition, metabolism, and composition of marine organisms; pigments, toxins, hormones, and luminescence. Mr. Ikawa. Prerequisite: Biochem. 601 or equivalent. 2 lec/2 cr. (Alternate years; offered in 1975-76.)

## 722. NEUROCHEMISTRY

The biochemistry of the nervous system; metabolism and alterations of normal brain chemistry by drugs, chemicals, nutrition, memory, and learning; pathological changes. Mr. Stewart. Prerequisite: biochemistry. 4 cr. (Alternate years; offered in 1975-76.)

## 751. PRINCIPLES OF BIOCHEMISTRY

Fundamental biochemistry; chemistry, metabolism, and biological function of nucleic acids, proteins, carbohydrates, and lipids. Mr. Klippenstein and Mr. Stewart. Prerequisite: organic chemistry or permission of instructor. 3 lec/1 lab/4 cr.

## 752. TOPICS IN BIOCHEMISTRY

A detailed consideration of metabolism and the current developments in biochemistry. Prerequisite: Biochem. 751. 2 lec/2 cr.

## 760. ENZYME CHEMISTRY

Structure, properties, and function of enzymes; kinetics and mechanisms of enzyme-catalyzed reactions; purification, characterization, and assay of enzymes. Mr. Klippenstein. 3 lec/1 lab/4 cr. (Alternate years; offered in 1975-76.)

## 770. BIOCHEMICAL GENETICS

The mechanisms of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Mr. Green. Prerequisite: Biochem. 751 or permission of instructor. 3 lec/1 lab/4 cr. (Alternate years; offered in 1975-76.)

## 781. THE NUCLEIC ACIDS

Chemistry and metabolism of nucleic acids; molecular structures, purification and separation, biosynthesis, and biological functions. Mr. Herbst. Prerequisite: organic chemistry and biochemistry. 3 lec/3 cr.

## 795, 796. INVESTIGATIONS IN BIOCHEMISTRY

Prerequisite: permission of instructor. Subject matter and hours to be arranged. 2 cr.

## 811. BIOCHEMISTRY OF LIPIDS

The chemistry, metabolism, and function of lipids. Mr. Smith. Prerequisite: Biochemistry 751 or equivalent. 3 cr.

## 832. BIOCHEMISTRY OF CARBOHYDRATES

The chemistry, metabolism, and functions of carbohydrates. Emphasis will be placed on polysaccharides, glycoproteins, and the nature of cell surfaces. Mr. Ikawa. Prerequisite: Biochemistry 751 or equivalent. 2 lec/2 cr. (Alternate years; offered in 1976-77.)

## 842. BIOCHEMICAL REGULATORY MECHANISMS

The non-replicative functions of DNA will be considered. The topics to be covered are: transcriptional and translational control of protein synthesis; regulation of the quantity of protein by control of rates of synthesis and degradation; hormonal control of metabolism; control of metabolic pathways by allosteric enzymes and repression. Mr. Stewart. Prerequisite: a course in biochemistry. 3 lec/3 cr. (Alternate years; offered in 1976-77.)

## 850. PHYSICAL BIOCHEMISTRY

The physical chemistry of biological molecules with emphasis on the structure and interactions of proteins. Included will be a consideration of the physical methods commonly used in the study of proteins and nucleic acids. Mr. Klippenstein. Prerequisite: physical chemistry and Biochemistry 751 or equivalent. 3 lec/3 cr. (Alternate years; offered in 1976-77.)

## 852. ADVANCED BIOCHEMISTRY LABORATORY

Application of chemical and physical techniques to the purification and characterization of proteins and nucleic acids. To be taken in conjunction with Biochemistry 850. Mr. Klippenstein. 2 lab/2 cr. (Alternate years; offered in 1975-76.)

## 897, 898. BIOCHEMISTRY SEMINAR

Presentation and discussion of recent investigations. Prerequisite: permission of the department chairman. 0 cr.

## 899. MASTER OF SCIENCE THESIS

To be arranged. 6-10 cr.

## 999. DOCTORAL RESEARCH

# Biology:—Intercollege Biological Sciences Organization (60)

**Chairman:** Edward Francq

The Master of Science and Master of Science for Teachers programs in biology are administered by the Intercollege Biological Sciences Organization, which is composed of faculty members involved in teaching and research in various biological sciences. Students in these degree programs consult with the Graduate Advising Committee in planning their individual programs. At present, participating faculty are drawn from the following areas; molecular, cellular, and developmental biology; systematics and evolution; physiology; anatomy and nutrition; genetics, ecology; and pathobiology.

## Master of Science

This is a general, non-thesis program which is applicable to interests which may not be met in a formal department. Curricula may be individually designed for persons working for agencies which require advance, in-breadth training in the biological sciences, or for those who wish to prepare for junior or community college teaching. Applicants should have a bachelor's degree in biology, zoology, botany, microbiology, or equivalent.

## Master of Science for Teachers (MST)

This program is designed to provide experienced and/or certified secondary school teachers with an opportunity to update and expand their knowledge of biology. Courses are chosen from the participating biological science disciplines in consultation with the graduate student's adviser.

Inquiries concerning the requirements for these programs should be addressed to the chairman of the Intercollege Biological Sciences Organization, or M. Haugstad, chairman of the Graduate Advising Committee, Department of Botany.

See course listings in the departments of animal sciences, biochemistry, botany and plant pathology, microbiology, I.N.E.R., plant science, zoology, and the Interdepartmental Genetics Program, for offerings.

# Botany and Plant Pathology

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## Botany and Plant Pathology (19)

**Chairman:** Robert Blanchard

**PROFESSORS:** Albion Hodgdon, Arthur Mathieson, Avery Rich, Richard Schreiber

**ADJUNCT PROFESSOR:** Alex Shigo

**ASSOCIATE PROFESSOR:** A. Linn Bogle

**ASSISTANT PROFESSORS:** Alan Baker, Robert Blanchard, May Haugstad, Russell Kinerson, William MacHardy, Subhash Minocha

**ADJUNCT ASSISTANT PROFESSOR:** Terry Tattar

Students admitted to graduate study in botany and plant pathology are expected to have adequate preparation in basic botany courses and in the physical sciences.

The candidate for the Master of Science degree will meet the Graduate School's requirements for the degree and, in addition, will be required to defend a thesis based on field or laboratory research.

A student who is working toward the Doctor of Philosophy degree will be advanced to candidacy for the Ph.D. after a successful comprehensive examination and completion of the following language requirement: a reading knowledge of at least one foreign language. The Guidance Committee may request a reading knowledge of two foreign languages, or a reading knowledge of one foreign language and proficiency in a cognate field such as statistics or computer techniques. The student will be required to defend a dissertation which is to be a substantial contribution to botanical knowledge.

All botany and plant pathology graduate students without professional teaching experience will satisfy the following departmental teaching requirement: each student will assist a faculty member for one semester in teaching an introductory botany course; a Ph.D. candidate will assist for one additional semester in an advanced botany course. Each student will also register for one semester of Section 9, Botanical Teaching, of either Botany 795-796 or Botany 895-896.

The department's areas for graduate study include: plant physiology, Ms. Haugstad, Mr. Minocha; plant ecology, Mr. Kinerson; systematic botany, Mr. Hodgdon; phycology, marine-freshwater, Mr. Mathieson, Mr. Baker; plant pathology, Mr. Rich, Mr. Blanchard, Mr. MacHardy, Mr. Shigo; plant morphology and anatomy, Mr. Bogle; mycology, Mr. Blanchard; cell biology, Mr. Schreiber and Ms. Haugstad; developmental botany, Mr. Minocha.

### (606) 606. PLANT PHYSIOLOGY

Function of higher plants; water relations, metabolism, growth, and development. Prerequisite: Bot. 411, 412, 503, or Plant Science 421 and one year of chemistry or permission of instructor. Mr. Minocha, Mr. Pollard. 3 lec/1 lab/4 cr.

### 717. GENERAL LIMNOLOGY

Special relationships of freshwater organisms to the chemical, physical, and biological aspects of their environment; factors regulating their distribution; and the primary and secondary productivity of lakes. Prerequisite: Biology 541 or equivalent. Individual projects. Mr. Baker, Mr. Haney. 3 lec/4 cr.

### 719. FIELD LIMNOLOGY

Principles of freshwater ecology, from a variety of habitats; the methods used to study lakes and interpret data. Occasional Saturday field trips. Prerequisite: prior or simultaneous enrollment in Bot. 717 and permission of instructor. Mr. Baker and Mr. Haney. 2 lab/3 cr.

### 721. FRESHWATER PHYCOLOGY

Identification, classification, ecology, and life histories of the major groups of freshwater algae. Periodic field trips. Prerequisite: Bot. 411, 412, or 503. Mr. Baker. 2 lec/2 lab/4 cr.

### 722. MARINE PHYCOLOGY

The identification, classification, ecology, and life histories of the major groups of marine algae, particularly the benthonic marine algae of New England. Periodic field trips. Prerequisite: Bot. 411, 412, or 502. Mr. Mathieson. 2 lec/2 lab/4 cr. (Alternate years; offered in 1975-76.)

### 723. MARINE ALGAL ECOLOGY

Distribution, abundance, and growth of marine plants in relation to their environment. Scheduled field trips and an independent research project are required. Prerequisite: Bot. 722, Zoo. 715, or permission of instructor. Mr. Mathieson. 2 lec/1 lab/4 cr. (Alternate years; offered in 1976-77.)

### 724. FRESHWATER ALGAL ECOLOGY

Survey of freshwater algal habitats, man's impact on algal communities of lakes and streams. Winter and spring field problems. Mr. Baker. Prerequisite: Bot. 721 or permission of instructor. 2 lec/2 lab/4 cr.

### 732. CELL BIOLOGY

Structure, behavior, and development of cells; the cellular basis of heredity. Prerequisite: one year of biological science and chemistry. Mr. Schreiber. 3 lec/1 sem/4 cr.

### 735. CELL PHYSIOLOGY (PLANT)

Function of living cells, emphasis on algal cells. Prerequisite: one year of general chemistry and biological science. Ms. Haugstad. 2 lec/2 lab/4 cr.



## 741. ECOSYSTEM ANALYSIS

Ecosystem structure and function; energy flow and biochemical cycles. Computer simulations of natural ecosystems. Prerequisite: Biology 541 or permission of instructor. Mr. Kinerson. 1 lec/1 lab/1 colloquium/4 cr.

## 742. PHYSIOLOGICAL ECOLOGY

Physiological responses of plants to the physical environment; photosynthesis, water relations, mass and energy flow. Prerequisite: Bot. 606 or permission of instructor. Mr. Kinerson. 1 lec/1 lab/1 colloquium/4 cr.

## 747. AQUATIC HIGHER PLANTS

Flowering plants, fern relatives, and Bryophytes found in and about bodies of water in the northeastern United States; extensive field and herbarium work, preparation techniques, and collections. Prerequisite: Bot. 506. Mr. Hodgdon. 1 lec/1 colloquium/1 lab/4 cr.

## 751. PLANT PATHOLOGY

Nature, symptomatology, etiology, and classification of plant diseases. Prerequisite: Bot. 411 or 412, or equivalent. Mr. Rich. 2 lec/2 lab/4 cr.

## 752. MYCOLOGY

Parasitic and saprophytic fungi; growth, reproduction, and identification; preparation of pure cultures. Prerequisite: Bot. 411 or 412, or equivalent. Mr. Blanchard. 2 lec/2 lab/4 cr. (Alternate years; offered in 1975-76.)

## 753. FOREST PATHOLOGY

Principles, etiology, epidemiology, and control of forest and shade tree diseases. Prerequisite: Bot. 411 or 412, or equivalent. Mr. Blanchard. 2 lec/2 lab/4 cr.

## (754). PRINCIPLES OF PLANT DISEASE CONTROL

Exclusion, eradication, protection, immunization, and the specific practical methods used to control plant diseases. Prerequisite: Bot. 751 or 753. Mr. MacHardy. 2 lec/2 lab/4 cr. (Alternate years; offered in 1975-76.)

## 758. PLANT ANATOMY

Anatomy of vascular plants, emphasizing structure and development of basic cell and tissue types, and of the major plant organs. Prerequisite: Bot. 411, 412, or 503. Mr. Bogle. 2 lec/2 lab/4 cr. (Alternate years; offered in 1976-77.)

## 762. MORPHOLOGY OF THE VASCULAR PLANTS

Comparative form and structure of the major living and extinct

groups; evolutionary modifications of the vegetative and reproductive organs, and the basic life history pattern. Prerequisite: Bot. 411, 412, or 503. Mr. Bogle. 2 lec/2 lab/4 cr. (Alternate years; offered in 1975-76.)

## 764. MICROTECHNIQUE

Methods of preserving cell and tissue structure, embedding, sectioning, and staining plant tissues, and an introduction to microscopy. Prerequisite: permission of instructor. Mr. Bogle. 2 lec/2 lab/4 cr. (Alternate years; offered in 1976-77.)

## 767. ADVANCED SYSTEMATIC BOTANY

Principles and rules of plant classification and nomenclature; plant families; field and herbarium work. Prerequisite: Bot. 566. Mr. Hodgdon. 1 lec/1 colloquium/1 lab/4 cr. (Alternate years; offered in 1975-76.)

## 795-796. INVESTIGATIONS IN: 1) SYSTEMATIC BOTANY; 2) PLANT PHYSIOLOGY; 3) PLANT PATHOLOGY; 4) PLANT ANATOMY; 5) PLANT ECOLOGY; 6) MYCOLOGY; 7) CELL BIOLOGY; 8) PHYCOLOGY; 9) BOTANICAL TEACHING; 10) MORPHOLOGY; 11) CELL PHYSIOLOGY; 12) SCIENTIFIC WRITING

Individual projects under faculty guidance. Elective only with permission of instructor. Hours to be arr. 2-4 cr.

## 822. ADVANCED MARINE PHYCOLOGY

Classification, ecology, and life histories of marine algae considered at an advanced level. Seminars, discussions, assigned reading, and laboratory. Mr. Mathieson. Prerequisite: Botany 722 or its equivalent. 4 cr.

## 830. MORPHOGENESIS

Principles of differentiation; involvement of internal and external factors in cellular and organismic development. Mr. Minocha. Prerequisite: Bot. 606 or 735 or 758 or permission of instructor. 3 lec/1 conf/4 cr.

## 843. THE PLANT AND THE MICROCLIMATE

This course offers a physical approach to the study of productivity, water-relations, and the distribution of individual plants and plant communities. Soil and atmospheric physics will be presented to provide the student with a working knowledge of the relationships between the physical environment and the plant world. Laboratories will provide practical experience with the instrument design, calibration, and use for measurement of plant and environmental factors. Mr. Kinerson. Prerequisite: permission of instructor. 3 lec/1 2-hr. lab/4 cr. (Alternate years, offered in 1976-77.)

# Business Administration

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## 851. CELL CULTURE

A consideration of the theory and principles fundamental to the cultures of cells in vitro. An introduction to the techniques of preparing and maintaining animal, plant, insect, and fish cell cultures. The application of cell culture to contemporary research in the biological sciences. Mr. Strout and staff, Mr. Metcalf, and Ms. Haugstad. Prerequisite: Microbiology 503, General Microbiology, and permission of instructor. (Also offered as Microbiology 851 and Animal Science 851.) 2 lec/lab/4 cr.

## 852. METHODS IN MYCOLOGY

Methods and techniques utilized in various aspects of mycological research. Preparation of media; culture techniques for isolation and growth; maintenance of stock cultures; cytochemical tests; and controlled development of representative species in the three major groups of fungi; fungal physiology, and ultrastructural techniques will be stressed. Mr. Blanchard. Prerequisite: Botany 752 or permission of the instructor. 2 lec/open lab/4 cr. (Alternate years; offered in 1976-77.)

## 853. ADVANCED PLANT PATHOLOGY

Advanced theories and methods in plant pathology. Mr. MacHardy. Prerequisite: Botany 751 or 753 and permission of instructor. Assigned reading, conferences. Lab/4 cr. (Alternate years; offered in 1976-77.)

## 861. PLANT GEOGRAPHY

The distribution of plants, a consideration of vegetation types and floras, and problems of endemism with emphasis on North America; the major influential factors such as geologic, climatic, edaphic, and biotic, including man's activities. The major contributions from Humboldt to the present time. Mr. Hodgdon. Prerequisite: permission of instructor. 1 lec/1 2-hr colloquium/field trips/4 cr. (Alternate years; offered in 1976-77.)

## 895-896. INVESTIGATIONS IN: 1) SYSTEMATIC BOTANY, 2) PLANT PHYSIOLOGY, 3) PLANT PATHOLOGY, 4) PLANT ANATOMY, 5) PLANT ECOLOGY, 6) MYCOLOGY, 7) CELL BIOLOGY, 8) PHYCOLOGY, 9) BOTANICAL TEACHING, 10) MORPHOLOGY, 11) CELL PHYSIOLOGY, 12) SCIENTIFIC WRITING

Individual projects under faculty guidance. Elective only by permission of the appropriate instructor. Hours to be arranged. 2-6 cr.

## 899. MASTER OF SCIENCE THESIS

6-10 cr.

## 999. DOCTORAL DISSERTATION

## Business Administration (30)

**Director of M.B.A. Programs:** Allan R. Cohen

**PROFESSORS:** Robert F. Barlow, John A. Beckett, Jan E. Clee, Stephen L. Fink, Herman Gadon, James O. Horrigan, John L. Korbel, Dwight R. Ladd, Donald C. Marschner, Samuel R. Reid, Robin D. Willits, Dwayne E. Wrightsman

**ASSOCIATE PROFESSORS:** Allan J. Braff, Dale G. Broderick, Allan R. Cohen, R. Stephen Jenks, Richard L. Mills, Barry Shore, Linda G. Sprague, William E. Wetzel, Jr.

**ASSISTANT PROFESSORS:** John Burt, Fred Kaen, George Miaoulis

**INSTRUCTOR:** Donald D. Wells

The Whittemore School day and evening programs leading to the degree of Master of Business Administration are designed to prepare graduates for professional careers in administration in both profit and not-for-profit organizations in a rapidly changing world. The MBA programs are directed toward a broad preparation in general administration through the study of: 1) the increasing body of relevant knowledge drawn from the behavioral sciences, mathematics, and economics; 2) the existing and emerging processes and institutions of the functional fields of administration; and 3) the role of business and other organizations in a complex and ever-changing society.

There is a consistent emphasis on developing basic analytical skills rather than on developing extensive technical expertise. Also, the program fosters the ability to utilize conceptual and theoretical material in the analysis and solution of practical problems.

Candidates for admission must possess a bachelor's degree from an accredited college or university. In addition, all candidates are expected to take the Admission Test for Graduate Study in Business (ATGSB) given by the Educational Testing Service. Details concerning the dates and locations for these examinations may be obtained from Educational Testing Service, Box 966, Princeton, New Jersey 08540.

The Whittemore School welcomes applicants with an above-average academic record in any undergraduate specialty other than business or commerce. No previous exposure to business courses is expected. However, previous work in mathematics, economics, the behavioral sciences, and the branches of engineering are of particular usefulness for graduate study in administration. Because of the increasing use of mathematical concepts, models, and notation in the practice and study of administration, applicants should normally have successfully completed one year of college mathematics, preferably including an introduction to calculus. Students lacking this background may still enroll in the program, provided they obtain adequate substitute preparation prior to beginning the program.

In all cases, the applicant's entire educational background, relevant experience, references, and professional aims will be considered in the admissions process. Exceptions may be made to any of the foregoing requirements by the Committee on Admissions.

The Whittemore School day MBA program consists of an integrated sequence of 21 courses requiring two years of study which can be started only in the fall semester. During the first year, 13 required courses or part courses in the basic disciplines (quantitative analysis, economics, and behavioral science) and the functional areas of management (accounting, marketing, operations management, and financial management) are integrated into an overall study of the process of administration. Special attention is also given to the study of the modern corporation as a partly economic, legal, and social organization by requiring all students to complete the course, *The Organization and Its Environment*.

The second year of the day program continues the emphasis on overall management by requiring all students to complete the integrating course, *Business Policy*. In addition, with the help of a faculty adviser, the student will select the equivalent of seven four-credit elective courses with some concentration in an area of special interest. Students are encouraged to select appropriate graduate-level courses offered by other colleges of the University as well as by the Whittemore School.

The evening MBA program involves completion of 18 courses offered in an integrated sequence over three years. The evening program may normally be started only in the fall term and, because of the cumulative nature of the program, students should expect to stay on schedule with their class. The program is designed for the non-business undergraduate and is aimed at broad training rather than intensive specialization. It is comparable to the day MBA program in curriculum, but specially tailored to the content and scheduling needs of people working full time.

Further information on both the day and evening MBA programs can be obtained by writing to the dean, Whittemore School of Business and Economics, University of New Hampshire, Durham, New Hampshire 03824.

## **705. OPERATIONS RESEARCH**

Synthesis and analysis of mathematical decision models; mathematical programming, networks, inventory, queuing, scheduling, and Markovian models. Prerequisite: permission of instructor. 4 cr.

## **(712) 712. ORGANIZATIONAL CHANGE**

Process of change in organizations. Change strategies; role of the change agent and his/her relation to the client system. Bases of resistance to change and problems encountered by internal and external change agents. Theoretical reading material, cases, and exercises. Prerequisite: permission of instructor. 4 cr.

## **713 (713). INTERPERSONAL AND GROUP DYNAMICS**

Dynamics of small groups through the use of the class itself as an intensive laboratory study group. Students examine their own behavior and its effects on others through the use of the Laboratory Training Group (T-group), and develop conceptual ability and behavioral skills. Readings in group dynamics, interpersonal relations, and sensitivity training. Prerequisite: permission of instructor. Lab fee. 4 cr.

## **714. CONFLICT MANAGEMENT**

Conflict among individuals, small groups, and organizations. Analysis of cases, readings, simulations, and roleplays (often using videotape) develops useful concepts and skills for dealing with conflict. Students examine their own behavior in coping with conflicts within the class. Field project required. Prerequisite: permission of instructor. 4 cr.

## **717. ADVANCED FINANCIAL ACCOUNTING**

Theory and practice as they contribute to the significance and limitations of the financial statements. Prerequisite: permission of instructor. 4 cr.

## **718. COST AND MANAGEMENT**

Effective use of cost accounting, cost analysis, and budgeting in planning and controlling operations. Analysis of cost behavior, direct and absorption costing, cost-price-volume relationship, distribution costs, transfer pricing, and capital expenditure analysis. Prerequisite: permission of instructor. 4 cr.

## **720. AUDITING**

The independent auditor and his/her attest function in society. Professional ethics and responsibility. Audit concepts, procedures, objectives, and reports. Operational audits, social audits, and management services. Prerequisite: Admin. 717 or permission of instructor. 4 cr.

## **722. ACCOUNTING SEMINAR**

Special topics. Prerequisites: Admin. 717 or 718, depending on topics, and consent of instructor. 4 cr.

## **728. STATISTICAL DECISION-MAKING**

Probability and statistics applied to decision problems. Bayesian approach to decisions under uncertainty, which explicitly injects prior judgements of decision-makers and the consequences of alternative actions. Prerequisite: Admin. 424 or equivalent. 4 cr.

## **730. INVESTMENTS ANALYSIS**

Capital market patterns and techniques useful for security an-

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alysis. Securities, market institutions, yield series, random walks, intrinsic-value analysis, and portfolio management. Security analysis research projects. Prerequisite: permission of instructor. 4 cr.

## 732. EXPLORATIONS IN ENTREPRENEURIAL MANAGEMENT

Past and probable future role of the entrepreneur in the economic and social development of the U.S. Differences between entrepreneurial and administrative management. Mythology of the "American Dream," entrepreneur as a change agent, entrepreneurial motivation and behavior patterns, venture-capital markets, and role of the entrepreneur in non-profit institutions. Prerequisite: permission of instructor. 4 cr.

## 741. TRANSPORTATION

Problems of American transportation system. Economic structure of transportation industries; competition among the several modes. Public policy questions: merger, cost-benefit analysis of facilities, for example. Freight transportation; problems of passenger transportation, especially in urban areas. Prerequisite: permission of instructor. 4 cr.

## 745. INTERNATIONAL BUSINESS

Issues and problems confronting managers in the international economy. Emphasis on problems of working across national borders rather than on those encountered within the framework of different national economies, cultures, and institutions. For managers working in a multinational enterprise. Prerequisite: permission of instructor. 4 cr.

## 747 (747). FEDERAL TAXATION

Current federal-income, estate, and gift taxes and their impact on corporations, partnerships, and individuals. Tax analysis and decision-making. 4 cr.

## 750. MARKETING MANAGEMENT

Practical application of theories taught in Admin. 651 or 808. Planning, organization, and control of marketing activities in large corporations and small businesses; new product development; pricing policies; selection of channels of distribution; interrelationships between marketing, production, and finance. Sound policy formulation and decision making established through analysis of cases and computer simulation. Prerequisite: a basic marketing course. 4 cr.

## 751. ADVERTISING AND PROMOTION

Advertising, personal selling, and other promotional tools to help solve marketing problems; advertising as a medium of communications and as a social-cultural force in the Western world.

Prerequisite: Admin. 651, 808, or permission of instructor. 4 cr.

## 752. MARKETING RESEARCH

Identification, collection, and analysis of data for the marketing process. Strengths, limitations, environment, and evaluation of research in the marketing process. Prerequisite: Admin. 424 and 651 or their equivalent. 4 cr.

## 754. CONSUMER BEHAVIOR

Consumer-firm relationship; concepts from contemporary social science findings, particularly small group studies, Learning, memory, cognition, motivation, emotion, perception concepts and global models related to present and prospective marketing activities of a business organization. Prerequisite: Admin. 651 or permission of instructor. 4 cr.

## 755. ADVANCED BUSINESS FINANCE

Development of analytical tools and practical skills for recognizing and solving complex problems of business finance. Working-capital management, capital budgeting, cost of capital, capital structure, and dividend policy. Prerequisite: Admin. 653 or 806. 4 cr.

## 756. MANAGEMENT OF FINANCIAL INSTITUTIONS

How financial institutions manage their sources and uses of funds; impact of external environmental factors upon the operation and performance of financial institutions. Optimal portfolio strategies for commercial banks, savings and loan associations, mutual savings banks, insurance companies, and pension funds. Implications of monetary theory for individual financial institution policies; credit analysis; competition among financial institutions; regulation of financial institutions. 4 cr.

## 770. PERSONNEL ADMINISTRATION

Role of personnel administration and human resource management in achievement of goals in "for-profit" and "not-for-profit" organizations. Functions of management; scope, technique, and current issues of personnel administration; organization of personnel activities and staff. How managers relate to personnel administration and interact with personnel administration staff and services. Prerequisite: permission of instructor. 4 cr.

## 798. SEMINAR IN ADMINISTRATION

Special topics; may be repeated. Prerequisite: consent of adviser and instructor. Variable 1-4 cr.

**800. INTRODUCTION TO THE STUDY OF BUSINESS**

Introduction to information sources and business institutions. Orientation in communication strategies and techniques. Identification of critical issues in economic organizations and approaches to business education. (All 800-level courses normally open to Master of Business Administration students only.) 2 cr.

**801. STATISTICS**

Basic mathematical and statistical concepts useful in managerial decision making. Probability, statistics, decision trees, and mathematical models. Emphasis is on applications. 3 cr.

**802. MODELS FOR ANALYSIS AND DECISION MAKING**

Synthesis and analysis of models as aids in describing systems and in making effective management decisions. System definition, conceptualization, formulation, data collection, validation, analysis, and managerial implementation. Qualitative as well as mathematical models are covered. 2 cr.

**803. HUMAN BEHAVIOR IN ORGANIZATIONS**

To provide students with an understanding of behavioral science concepts and their use in the analysis of individual, group and leadership relationships in organizations, and to develop skills in dealing with others at work. 3 cr.

**804. MANAGEMENT ORGANIZATION**

Theories of organization and analysis of contemporary forms and structure. Concern is with development of rational management processes in a dynamic society. 2 cr.

**806. FINANCIAL MANAGEMENT**

Concepts and techniques for determining the need for, the acquisition of, and the management of, financial resources of the business. 3 cr.

**808. MARKETING**

Identification, development, and retention of markets for the goods and services offered by the firm. Attention is given to the dynamics of demand and to the blending of the marketing mix. 3 cr.

**810. OPERATIONS MANAGEMENT**

Analysis of operational problems in the product and service sectors, focusing on production system design and development; emphasis on standards, capacity, inventory, scheduling and control. 3 cr.

**811. THE ORGANIZATION AND ITS ENVIRONMENT**

Study of the modern corporation as a partly economic, legal, and social organization, including examination of widely held views of business and views of businessmen about themselves. 3 cr.

**815. FINANCIAL ACCOUNTING**

Introduction to the accounting methods employed in organizations to determine and communicate their financial position to interested parties outside the organization. 3 cr.

**816. BUDGETING AND CONTROL**

Introduction to various models employed by organizations in the financial planning and control processes. 2 cr.

**817. BUSINESS CONDITIONS AND ECONOMIC FORECASTING**

Managerial effects of historical and forecasted movements in interest rates, national income, inflation, and unemployment. 2 cr.

**818. MANAGERIAL ECONOMICS**

An economics approach to the conceptualization, analysis, and management of revenues, costs, and profits. 2 cr.

**820. BUSINESS POLICY**

A "capstone" course, focused on industries, companies, and other organizations in operation, and studied through case examples, with emphasis on integration of materials covered in prior courses. 4 cr.

**848. LAW: USE AND APPLICATION IN BUSINESS**

The use and understanding of law as it applies to business judgement and policy decision-making. Emphasis on learning basic legal rules and their application. Areas considered include: contracts, corporations, agencies, partnerships, administrative agencies, commissions, and other related business matters. Case-method teaching with outside research. 4 cr.

**861. THE PHILOSOPHY OF MANAGEMENT SCIENCE**

A study of management from a systems analysis point of view. 4 cr.

**895. SPECIAL PROJECTS AND INDEPENDENT STUDY**

Projects, research, and reading programs in areas required for concentration. Sixty days advance approval of the student's plan of study by adviser and by proposed instructor required. Staff. 4 cr.

# Chemical Engineering

## Chemical Engineering (46)

**Chairman:** Stephen S.T. Fan

ASSOCIATE PROFESSOR: Stephen S.T. Fan

ASSISTANT PROFESSORS: Gail D. Ulrich, Charles E. Wyman

VISITING ASSISTANT PROFESSOR: Virendra K. Mathur

To be admitted to graduate study in chemical engineering an applicant is expected to have completed a course of study substantially equivalent to that required for the degree of Bachelor of Science in Chemical Engineering in this University. However, students with good undergraduate records but with deficiencies in certain areas may be admitted on condition that they complete specified courses without credit to make up for their deficiencies.

A minimum of 30 credits, which must include Chemical Engineering 813, 815, 816, and 823, is required for the Master of Science degree in Chemical Engineering. The core-courses requirement can be waived only in special cases with permission from the department faculty. A candidate for the Master of Science degree must prepare a thesis, for which up to six credits will be allowed, unless the candidate is specifically exempted by the faculty because of previous research experience.

For students who are interested in graduate studies beyond the Master of Science degree, an interdepartmental Engineering Doctor of Philosophy program is available which includes the following areas of specialization: engineering system design, signal processing, theoretical and applied mechanics, and transport phenomena. For details refer to the section entitled Engineering Ph.D. program on page 70.

Courses numbered between 600 and 699 may be taken for graduate credit by non-majors only.

Permission of the instructor and consent of the student's adviser are required for enrollment in all chemical engineering courses.

### 701. HIGH POLYMERS

Principles and practice of industrial methods of polymerization and processing. Physical and chemical testing of various polymers. 3 lec/1 lab/4 cr.

### 712. INTRODUCTION TO NUCLEAR ENGINEERING

Development of nuclear reactors; basic binding-energy physics; radioactivity; elements of nuclear reactor theory; engineering problems of heat transfer, fluid flow, materials selection, and shielding; environmental impacts. 4 cr.

### 750. INTRODUCTION TO PROCESS SIMULATION AND OPTIMIZATION

Analysis and numerical simulation of controlled chemical sys-

tems. Laplace transforms. Transient responses. Solution of nonlinear equations. Simultaneous, ordinary differential equations; Runge-Kutta, Crank-Nicholson methods. Steady state optimization: linear programming, classical search techniques. Unsteady state optimization: Pontryagin's maximum principle. 3 lec/1 rec/4 cr.

### 772. PHYSICOCHEMICAL PROCESSES FOR WATER AND AIR QUALITY CONTROL

Origin and characterization of pollutants. Controls, including filtration, sedimentation, coagulation and flocculation, adsorption and absorption. Applied fluid mechanics, mass transfer, and kinetics. Thermal pollution, chemical treatment, oil spills on water, and aeration. 3 lec/1 lab/4 cr.

### 813. ADVANCED FLUID MECHANICS

Basic equations describing behavior of static and dynamic fluid systems are derived. The equations of motions are derived and applied to laminar and turbulent flow. Momentum and energy equations are employed to analyze advanced problems associated with flow inside conduits. Flow of compressible fluids and boundary layer phenomena are examined briefly. 3 cr.

### 815. HEAT TRANSFER

Steady-state and transient heat conduction in solids; heat convection; analytic solutions, similarity relations, boundary-layer methods; radiation. 3 cr.

### 816. DIFFUSIVE MASS TRANSFER

Emphasis on the physical aspects of diffusion; theories of diffusion in dilute gases, dense gases, liquids, and solids; surface diffusion; mixing processes. Simultaneous heat and mass transfer. 3 cr.

### 823. ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS

A discussion of the multicomponent open system from the engineering viewpoint; the volumetric and phase behavior of pure substances and of multi-component systems at physical and chemical equilibrium; fugacity and activity; thermal properties of equilibrium, chemically reacting systems; introduction to statistical thermodynamics. 3 cr.

### 832. ADVANCED CHEMICAL ENGINEERING KINETICS

Discussion of specialized applied kinetics problems; catalysis; fast reaction and shock tubes; combustion and detonation processes; non-isothermal kinetics; heat and mass transfer in non-equilibrium, chemically reacting systems. 3 cr.

## 852. ADVANCED PROCESS DYNAMICS

An advanced treatment of process dynamics, including higher order processes and non-linear processes. Special attention is given to representing a complex process by differential equations, linearizing non-linear elements, and adequately controlling the entire system. 3 cr.

## 890. LITERATURE REPORT

Instruction in the use of the library for chemical engineering research. This course will culminate in the preparation of a literature report on a topic of mutual interest to the student and the chemical engineering faculty. 1 cr.

## 895, 896. GRADUATE INDEPENDENT STUDY

Directed reading or investigation at the advanced level on topics or problems in chemical engineering. 2-4 cr.

## 897, 898. GRADUATE SEMINAR

Discussion on topics of interest to graduate students and staff; reports of research progress; invited lectures by outside speakers. 0 cr.

## 899. MASTER'S THESIS

Original investigations in chemical engineering. 1-6 cr.

## Chemistry (47)

**Chairman:** Alexander R. Amell

**PROFESSORS:** Alexander R. Amell, Kenneth K. Andersen, Albert F. Daggett, Clarence L. Grant, Helmut Max Haendler, Paul R. Jones, Robert E. Lyle, Jr., James D. Morrison, Frank L. Pilar

**ASSOCIATE PROFESSORS:** David W. Ellis, Gloria G. Lyle, Colin D. Hubbard, Charles W. Owens, Albert K. Sawyer, J. John Uebel, James H. Weber, Charles M. Wheeler, Jr.

**ASSISTANT PROFESSOR:** N. Dennis Chasteen

The Department of Chemistry offers programs leading to three graduate degrees: Doctor of Philosophy, Master of Science, and Master of Science for Teachers. Entering graduate students (except for those desiring the M.S.T. degree) are expected to take proficiency examinations in chemistry to assist in starting the new student's graduate work at the proper level. These examinations will be offered at the beginning of the semester in September and in February.

The faculty of the chemistry department feels that the experience of teaching is a valuable part of the training of the graduate student. Therefore, all graduate students who are Doctor of Philosophy or

Master of Science candidates will obtain some teaching experience during their tenure.

## Doctor of Philosophy Degree

Admission to this program is based upon superior work in the usual undergraduate courses in inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry, as well as the normal supporting courses in mathematics and physics. This degree requires the completion of a research problem presented in the form of a thesis.

The Ph.D. candidate will be expected to demonstrate proficiency in reading chemical literature in German and French or Russian. He will also demonstrate to his doctoral committee that he has a broad basic knowledge of the field of chemistry: 1) by completing certain fundamental graduate courses, and 2) by means of a series of examinations in his major field. The principal emphasis of the last two years will be on the research project which will constitute the dissertation. During this time the doctoral candidate will present and defend an original research proposal before his doctoral committee.

## Master of Science Degree

Admission to this program is based upon a superior undergraduate average and requires satisfactory work in the usual undergraduate courses in inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry, as well as the normal supporting courses in mathematics and physics. This degree requires the completion of a research problem presented in the form of a thesis.

## Master of Science for Teachers Degree

This program is offered for candidates who hold a secondary-school teacher certification in chemistry. Courses leading to this degree will normally be chosen from Summer Session and Summer Institute offerings and require 30 semester hours in courses approved by the department chairman. Persons interested in this degree should confer with the chairman.

## Interdisciplinary Programs in Chemistry

Graduate students in chemistry may elect to enter one of the interdisciplinary programs offered jointly with the chemistry department and other departments. In these programs, the graduate student, with the advice of the guidance committee, elects courses in chemistry and in the related disciplines, and writes the dissertation on a research problem appropriate to interdisciplinary treatment.

# Chemistry

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Students interested in these programs should write to the chairman of the department for further information.

## Analytical Chemistry

### 762. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

Theory, instrumentation, and application of methods such as atomic absorption, conductimetry, coulometry, emission spectrography, gas chromatography, polarography, potentiometry, and spectrophotometry to chemical analysis. Prerequisite: Chem. 406; Chem. 684 as a prerequisite or concurrently or permission of instructor. (Students must register for Chem. 763 concurrently.) 3 lec/3 cr.

### 763. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS LABORATORY

Experimental parameters, error analysis, and applications of the methods covered in Chem. 762. (Must be taken concurrently with Chem. 762.) 1 lab/2 cr.

### 830. ADVANCED OPTICAL METHODS

Techniques of chemical identification and analysis utilizing optical instrumentation from the standpoint of both theory and application. Topics include NMR, ESR, X-ray fluorescence, mass spectrometry, electron beam microprobe. 3 cr.

### 831. ADVANCED ELECTRICAL METHODS

Techniques of chemical identification and analysis utilizing electrical instrumentation from the standpoint of both theory and application. Topics include controlled-current coulometry, A-C polarography, chronoamperometry, cyclic voltammetry, controlled potential coulometry. 3 cr.

### 832. CHEMICAL INSTRUMENTATION

The basic modules of chemical instrumentation, both electrical and optical. 3 cr.

### 833. CHEMICAL SEPARATIONS

The use of various separation techniques prior to analysis, and separations as a method of analysis are discussed. The application of statistics to chemical problems of analysis is covered. 3 cr.

## Inorganic Chemistry

### 774. INORGANIC CHEMISTRY

Basic theoretical concepts and their applications to inorganic reactions and compounds. Prerequisite: Chem. 683; Chem. 684

pre- or co-requisite; or permission of instructor. Undergraduates must take Chem. 775 concurrently. 3 cr.

### 775. INORGANIC CHEMISTRY LABORATORY

Synthesis and characterization of inorganic compounds with an emphasis on techniques not taught in other laboratory courses. Undergraduates must take Chem. 774 concurrently. 1 lab/2 cr.

### 803. ADVANCED INORGANIC CHEMISTRY I

Survey of some concepts of modern inorganic chemistry, serving as general background material for all graduate students and as basic fundamentals for further courses in inorganic chemistry: periodicity, stereochemistry and bonding in inorganic compounds, the crystalline state, reactions in solution, energetics, and elementary coordination chemistry. 4 cr.

### 804. ADVANCED INORGANIC CHEMISTRY II

Specialized topics for the advanced student. Topics may include advanced discussions of topics in Chemistry 803, inorganic reaction mechanisms, nonaqueous solvent systems, fluorine chemistry, bioinorganic chemistry, solid state chemistry. 3 cr.

### 847. ADVANCED INORGANIC CHEMISTRY III

Modern theory applied to spectra, magnetism, kinetics, and thermodynamics of coordination compounds. The formation of and reactions of coordination compounds including catalytic reactions. Prerequisite: Chemistry 803 or permission of instructor. 3 cr.

### 848. ADVANCED INORGANIC CHEMISTRY IV

The theory and practice of X-ray diffraction and the determination of crystal structure. Prerequisite: Chemistry 803 or permission of instructor. 3 cr.

## Organic Chemistry

### 651-652. ORGANIC CHEMISTRY

The principal classes of organic compounds, aliphatic and aromatic, with emphasis on class reactions and structural theory. Laboratory exercises in the preparation and purification of selected organic compounds. Prerequisite: Chemistry 404 or 406 or permission of instructor. 3 lec/3 cr. Students receiving credit for Chemistry 651-652 may not receive credit for either Chemistry 545 or Chemistry 547-548.

### 653-654. ORGANIC CHEMISTRY LABORATORY

Laboratory exercise to accompany Chemistry 651-652. 1 laboratory; 2 cr. Must be taken concurrently with Chemistry 651-652.



## 755. ADVANCED ORGANIC CHEMISTRY

Methods of synthesis and determination of structure, including stereochemistry, of complex organic compounds. Laboratory: synthesis and structural determination of complex organic compounds, techniques for the separation, determination of purity, and identification of compounds by spectroscopic and chemical means. Prerequisite: Chem. 547 or 651 or equivalent. (Students must register for Chem. 756 concurrently.) 3 cr.

## 801. THEORETICAL ORGANIC CHEMISTRY I

A discussion of the theoretical and experimental methods used in the study of reaction mechanisms and molecular stereochemistry. 4 cr.

## 802. THEORETICAL ORGANIC CHEMISTRY II

A continuation of Chem. 801. 3 cr.

## 811. SYNTHETIC ORGANIC CHEMISTRY I

Advanced discussion of heterolytic and homolytic substitution and elimination reactions of the major classes of organic compounds, with emphasis on the synthetic utility of these reactions. Permission of instructor. 3 cr.

## 812. SYNTHETIC ORGANIC CHEMISTRY II

Addition, oxidation, and reduction reactions and selected molecular rearrangements, with emphasis on the synthetic applications of these reactions. The synthesis and structure determination of complex organic compounds. Permission of instructor. 3 cr.

## 817, 818. SPECIAL TOPICS IN ORGANIC CHEMISTRY

Specialized courses for the advanced student. Topics may include reaction mechanisms, stereochemistry, spectroscopy, molecular biochemistry, steroids, alkaloids, organic sulfur compounds, and nitrogen heterocycles. 2 or 3 cr.

## Physical Chemistry

### 663. INTRODUCTORY RADIOCHEMICAL TECHNIQUES

Radiochemical techniques and laboratory practice in the use of apparatus in many fields of science which utilize radiochemical operations. Prerequisite: general inorganic chemistry and general physics. 2 lec/2 lab/4 cr.

### 683-684. ELEMENTARY PHYSICAL CHEMISTRY

The properties of gases, liquids, and solids; thermochemistry and thermodynamics; solutions, chemical equilibria, reaction rates, conductance, and electromotive force. Prerequisite: Mathe-

matics 426, Calculus II, and physics. Undergraduates must register for Chemistry 685-686 concurrently. 3 cr.

### 685-686. PHYSICAL CHEMISTRY LABORATORY

Experimental work illustrating the principles of chemistry. Emphasis is upon the measurement of thermodynamic properties, chemical kinetics, and methods of determining the structure of matter. Prerequisite: Mathematics 426, Calculus II, and physics. Must be taken concurrently with Chemistry 683-684. 2 lab/2 cr.

### 776. ADVANCED PHYSICAL CHEMISTRY

Foundations of quantum theory, elementary quantum mechanics, theory of spectra, statistical thermodynamics. Prerequisite: Chemistry 683-684. 4 cr.

### 778. CHEMISTRY OF LARGE MOLECULES

Basic chemistry of high-molecular-weight compounds, including synthetic polymers and substances occurring in living systems. Elementary aspects of the structures, syntheses, and properties of large molecules and their roles in modern science, technology, and living systems. Prerequisite: one semester of organic chemistry. 4 cr.

### 805. ADVANCED PHYSICAL CHEMISTRY I

An introduction to topics in quantum mechanics, group theory, and statistical thermodynamics which form the background of all areas of modern chemistry. 4 cr.

### 806. ADVANCED PHYSICAL CHEMISTRY II

Wave mechanics and quantum chemistry, spectroscopy, molecular structure; statistical thermodynamics, kinetics, and mechanism. Prerequisite: one year of physical chemistry. 3 cr.

### 821. PHYSICAL CHEMISTRY—CHEMICAL KINETICS

The kinetics of homogeneous and heterogeneous reactions in gaseous and liquid systems, including an introduction to very rapid reactions. Prerequisite: one year of physical chemistry. 3 cr.

### 822. PHYSICAL CHEMISTRY—CHEMICAL THERMODYNAMICS

The foundations and interrelationships of the theory of thermodynamics. The methods by which the theoretical principles may be applied to practical problems. 3 cr.

### 826. NUCLEAR AND RADIOCHEMISTRY

Nuclear structure and reactions, particle accelerators, radioactive decay, detection of particles, and the interaction of particles with matter. Application of radiochemistry to chemical systems and research. 3 cr.

# Chemistry

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## 827, 828. THEORETICAL CHEMISTRY I, II

The modern concepts and mathematical formalism of quantum mechanics and applications to electronic structures of atoms and molecules, spectroscopy, and the solid state. 3 cr.

## 829. THEORETICAL CHEMISTRY III

Statistical mechanics with applications to thermodynamics of non-ideal systems, intermolecular forces, and chemical kinetics. Permission of instructor. 3 cr.

## General Offerings:

Courses in which all areas of specialization participate.

## 708. RESEARCH TECHNIQUES

Lectures and laboratory to show experimental methods and interpretation of results. Topics include chromatography, data handling, nuclear magnetic resonance, mass spectrometry, elementary electronics, infrared and ultraviolet spectroscopy, and X-ray. 1-3 cr.

## 807. INTRODUCTION TO RESEARCH

A course to introduce the Doctor of Philosophy student to the planning, experimental methods, and interpretation of a research problem. The student will present and defend an original research proposal before a faculty committee. Must be completed satisfactorily by all doctoral students. Cannot be used for credit by Master of Science candidates. 2 cr.

## 895, 896. COLLOQUIUM IN CHEMISTRY: (1) INORGANIC CHEMISTRY, (2) ORGANIC CHEMISTRY, (3) THEORETICAL ORGANIC CHEMISTRY, (4) PHYSICAL CHEMISTRY, (5) ANALYTICAL CHEMISTRY

1-4 cr. Sections of the course may be taken to a total of 12 cr.

## 897, 898. SEMINAR

Presentation and discussion of recent investigations in chemistry. 1 cr.

## 899. THESIS—PROBLEMS IN CHEMISTRY

Conferences, library, and experimental work in some field of chemistry. Staff. Cr. to be arranged.

## 999. DOCTORAL RESEARCH

## Courses for the Master of Science for Teachers Degree

The following courses usually are offered only in the Summer Session.

## 781. THE TEACHING OF HIGH SCHOOL CHEMISTRY

Contemporary subject matter in general chemistry; choice of experiments for laboratory and lecture demonstrations; and presentation and evaluation of teaching methods which are effective in stimulating students. 4 cr.

## 782. MODERN INORGANIC CHEMISTRY FOR THE HIGH SCHOOL TEACHER

The current concepts on such topics as fundamental particles, atomic structure, nuclear reactions, electronic configurations and orbitals, chemical bonds, the periodic table, oxidation-reduction, acids and bases, energy relationships, and ionic reactions. 4 cr.

## 783. ANALYTICAL CHEMISTRY FOR HIGH SCHOOL TEACHERS

The principles of ionic equilibria in qualitative and quantitative analysis. Experimental work in qualitative analysis using the semimicro technique. The experimental work in quantitative analysis acquaints the student with the principles, techniques, and calculations of gravimetric and volumetric determinations. Some experimental work involves the use of the spectrophotometer in quantitative analysis and of the glass electrode method of measurement of pH. 8 cr.

## 784. MODERN APPROACH TO ORGANIC CHEMISTRY FOR HIGH SCHOOL TEACHERS

The structure and properties of organic compounds, including those of current interest and importance, such as natural and synthetic polymers, antibiotics, and medicinals. An understanding of the behavior of organic compounds will be based on the current theories of reactions. 8 cr.

## 785. PHYSICAL CHEMISTRY FOR HIGH SCHOOL TEACHERS

The laws of chemistry and their application to physical and chemical changes. Prerequisite: college physics, algebra, and trigonometry. 8 cr.

## 786. RADIOCHEMISTRY FOR HIGH SCHOOL TEACHERS

The theory of radioactive decay, the effects of radioactive decay upon matter, and the methods and techniques of the detection of radioactive decay. The uses of radiotracers in research. Prerequisite: general chemistry and general physics. 4 cr.

## 787. LABORATORY TECHNIQUES IN CHEMISTRY

Modern methods for the separation, identification, and estimation of substances. Experiments will be designed to assist the teacher by providing new subjects for laboratory demonstrations and student projects. Prerequisite: analytical and organic chemistry. 4 cr.

## 788. ADVANCED ORGANIC CHEMISTRY FOR HIGH SCHOOL TEACHERS

Types of homolytic and heterolytic reactions of organic compounds and their relationship to organic structures, including configuration and conformation. Prerequisite: Chemistry 784 or its equivalent. 4 cr.

## 789. ATOMIC AND MOLECULAR STRUCTURE

The methods of determining atomic and molecular structure, including ultraviolet and infrared spectroscopy and radiochemistry. 4 cr.

## Civil Engineering (48)

**Chairman:** Robert P. Vreeland

**PROFESSORS:** Victor D. Azzi, Charles O. Dawson, J. Harold Zoller

**ASSOCIATE PROFESSORS:** Louis H. Klotz, Harold E. Langley, Jr., Robert P. Vreeland, Tung-Ming Wang

**ASSISTANT PROFESSORS:** Paul L. Bishop, Dennis J. O'Brien

**ADJUNCT ASSOCIATE PROFESSORS:** Norman A. Abend, Gerald H. Batchelder

A candidate for the degree of Master of Science in Civil Engineering must have completed a baccalaureate degree in engineering, mathematics, or science. If the undergraduate work is deficient, the candidate may be required to take undergraduate courses without graduate credit in order to present the proper prerequisites for graduate courses in the area of a major and minor interests. In addition, other undergraduate courses may be required by the student's adviser in order to achieve an integrated program.

The candidate for the master's degree may elect Plan A or Plan B program. The Plan A program requires a minimum of 24 credits of graduate-level course work plus a thesis for which six graduate credits are normally awarded. In the case of highly original and unusual work, a maximum of nine credit hours may be awarded for the thesis. The Plan B requires a minimum of 30 hours of graduate-level course work plus a written paper, which is to be written in one of the project courses not included in the 30 credit minimum. The Plan B paper is equivalent to a thesis in style and quality, but not in scope. One bound copy of the thesis or Plan B paper is required by the department for its files. Additional bound copies are usually presented to the library and the candidate's adviser.

All candidates for the master's degree are required to take a final oral examination. The Examination Committee, appointed by the dean of the Graduate School from nomination by the department chairman, will consist of at least two senior faculty members from

within the civil engineering department and an additional senior faculty member usually selected from another department within the College of Technology. The oral final examination will consist of a defense of the thesis or Plan B paper as well as an examination of the engineering fundamentals leading to the master's degree. The thesis or Plan B paper should be given to the committee members at least two weeks prior to the date of the final oral examination.

The master's programs in Civil Engineering are becoming increasingly interdisciplinary. Candidates may be required to complete graduate-level courses in other departments in order to enlarge their educational experience and to acquire fundamental skills expected of a master's candidate. Program areas within the department include sanitary and environmental engineering, soil mechanics, foundation engineering, structural design, structural mechanics, transportation and urban systems planning, and others.

Ph.D. programs are available through the Engineering Ph.D. Program within the College of Technology. The Ph.D. is awarded in Engineering, and selected candidates work within one of four established areas of specialization. Most Ph.D. candidates with civil engineering backgrounds would work either in the theoretical and applied mechanics or the engineering systems design program areas. All interested candidates are advised to consult the graduate coordinator for the details of these programs. Additional information about the Engineering Ph.D. program is presented in the Engineering Ph.D. section of this catalog on page 70.

Courses numbered above 700 may be offered biennially or upon demand. Courses numbered between 600 and 699 may be taken for graduate credit only by non-majors. Permission of the instructor and consent of the adviser are required for enrollment in all Civil Engineering graduate courses. With the approval of the department chairman and graduate dean, six graduate credits taken at other institutions prior to admission to the University of New Hampshire Graduate School may be applied to the master's degree. Senior undergraduates interested in the dual bachelor's and master's degree programs should consult the appropriate section of this catalog under "Graduate Credits."

## 701. ADVANCED SURVEYING

Instrumental and analytical photogrammetry. Conformal mapping and its application to the state plan coordinate systems. Geodetic surveying. Error theory and its application to the planning and adjustment of surveys. Application of electronic computers to surveying calculations. Prerequisite: Civ. Eng. 505. 3lec/1lab/4cr.

## 711. COMMUNITY PLANNING

Social, economic, and physical factors; content and extent of desirable programs—including purpose and scope; preliminary survey; elements of land planning; the master plan; transporta-

# Civil Engineering

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tion and circulation systems; patterns of land use; legal, financial, environmental, and economic problems. Prerequisite: permission of instructor. 4 lec/4 cr.

## **714. CONTRACTS, SPECIFICATIONS, AND PROFESSIONAL RELATIONS**

Essential elements and legal requirements of engineering contracts; purposes and content of specifications; professional conduct, relations, registration, and ethics. Construction planning and management; cost analysis based on quantity surveys and unit-cost methods. Prerequisite: permission of instructor. 4 lec/4 cr.

## **721. PAVEMENT DESIGN**

Flexible and rigid pavements and bases for highways, airports, and city streets; pavement selection, construction methods, materials, specifications, and engineering cost estimates. Prerequisite: Civ. Eng. 620 and 665. 3 lec/1 lab/4 cr.

## **731. NETWORK PLANNING AND SCHEDULING**

Application of critical path methods (CPM) and project evaluation review technique (PERT) to the design and control of engineering projects. 1 lec/1 lab/2 cr.

## **732. SYSTEMS ANALYSIS**

An analysis of engineering projects encompassing social and economic criteria as well as engineering feasibility studies. 2 lec/2 cr.

## **743. ENVIRONMENTAL SAMPLING AND ANALYSIS**

Laboratory exercises in the techniques of water, wastewater, and solid-waste sampling and analysis. Interpretation of results from pollution surveys and operation of pollution control facilities; statistics of sampling and statistical evaluation of analytical data. Prerequisite: Civ. Eng. 643 or consent of instructor. 1 lec/1 lab/2 cr.

## **745. HYDROLOGY AND HYDRAULICS**

Occurrence and physical effects of water on the earth; meteorology, ground-water runoff and stream-flow routing, open-channel flow, reservoirs, control works, hydroelectric power, irrigation, drainage, and multipurpose projects. Prerequisite: Civ. Eng. 642. 4 lec/4 cr.

## **746. WASTEWATER TREATMENT PLANT DESIGN**

Choice of treatment units. Design of the components; preparation of a plan for a particular city that includes a suitable combination of the units previously designed. Prerequisite: Civ. Eng. 744. 3 lec/1 design period/4 cr.

## **747. WATER TREATMENT PLANT DESIGN**

Concepts, principles, and theory of plant design using a water source for a particular city and developing a treatment system for that community. Prerequisite: Civ. Eng. 744. 3 lec/1 design period/4 cr.

## **748. SOLID WASTE DISPOSAL**

Basic concepts and theory of collection and disposal systems. Design methods involved in disposal system. Prerequisite: Civ. Eng. 643. 3 lec/1 design period/4 cr.

## **751. TRANSPORTATION PLANNING**

Techniques used to predict demand for transportation service. Trip generation, distribution, mode choice, network assignment, and system evaluation. The use of computer models to study transportation facilities in New England. Prerequisite: Civ. Eng. 621 or permission of instructor. 3 lec/1 lab/4 cr.

## **752. TRAFFIC ENGINEERING**

Designing for and controlling traffic flow. Traffic control, capacity and volume calculations, parking, highway safety, geometric design, and traffic flow models. Design aspects and operational characteristics of traffic facilities. Prerequisite: Civ. Eng. 621. 4 lec/4 cr.

## **753. URBAN AND REGIONAL SYSTEMS ANALYSIS METHODS**

Mathematical techniques of analysis. Matrix operations, regression analysis, linear programming, network analysis, factor analysis, and stochastic systems. Computer applications to regional systems in New England. Prerequisite: Math 427 or permission of instructor. 3 lec/1 lab/4 cr.

## **754. ANALYSIS OF URBAN AND REGIONAL SYSTEMS**

The application of analytical techniques to regional systems in New England. Individual or group projects concerned with such systems as migration, transportation, health care, education, recreation, and sanitation. Prerequisite: Civil Engineering 753 or permission of instructor. 3 lec/1 lab/4 cr.

## **763. ADVANCED SOIL MECHANICS I**

The physical and mechanical properties of soil in relation to engineering structures. The theory of consolidation, shearing resistance, bearing capacity, settlement, slope stability, earth pressure, and seepage studies. Prerequisite: permission of instructor. 4 lec/4 cr.

## **765. FOUNDATION ENGINEERING**

Application of the principles of soil mechanics to selection of the type of substructure; determination of allowable soil-bearing

capacities based on rupture and settlement theories; determination of active and passive earth pressures; and foundation construction methods. Prerequisite: Civ. Eng. 665, 682, and senior standing. 3 lec/1 design period/4 cr.

## **768. SEEPAGE THROUGH EARTH STRUCTURES**

Groundwater flow, Darcy's Law, flow nets, Dupuit's theory and application, conformal mapping techniques, confined flow, flow through earth and rock structures, seepage towards wells. Prerequisite: Civ. Eng. 642 and 665. 2 lec/2 cr.

## **782. TIMBER DESIGN**

Properties and characteristics of structural woods, mechanics of wood, connection methods, design of timber members, and connections in beams, columns, and trusses, and glued laminates of wood. Prerequisite: Civ. Eng. 682 and permission of instructor. 1 lec/1 design period/2 cr.

## **784. STRUCTURAL ANALYSIS BY MATRIX AND NUMERICAL METHODS**

Unifying concept of basic structural analysis theories; matrix and numerical methods of analysis, and their application by linear graph concepts using computers. Prerequisite: Civ. Eng. 685. 3 lec/1 design period/4 cr.

## **790. INELASTIC STRUCTURAL DESIGN**

A continuation of modern design theory; ultimate design of reinforced concrete; plastic analysis of steel structures. 4 lec/4 cr.

## **793, 794. ADVANCED STRUCTURAL DESIGN I AND II**

Design in steel by elastic and plastic theories and in reinforced concrete by the working stress and ultimate strength methods for structural elements and connections using the appropriate controlling specifications. Prerequisite: Civ. Eng. 682 or permission of instructor. 3 lec/1 design period/4 cr.

## **795, 796. INDEPENDENT STUDY**

A limited number of qualified senior and graduate students will be permitted to pursue independent studies under faculty guidance. Seniors may write terminal theses reporting the results of their investigation. 2-4 cr.

## **822. HIGHWAY AND AIRPORT ENGINEERING**

Design of flexible and rigid pavements and bases for highways, airports, and city streets; pavement selection, construction methods, materials, specifications, and engineering cost estimates. Prerequisite: Civil Engineering 721. 2-4 cr.

## **855. MICROBIOLOGY OF WASTEWATER TREATMENT**

Detailed study of the microbiological aspects of wastewater treatment and the techniques used in the biological testing of water and wastewater. Prerequisites: Civil Engineering 744 and Microbiology 503, General Microbiology, or consent of instructor. 3 lec/1 lab/4 cr.

## **856. INDUSTRIAL WASTEWATER TREATMENT**

Detailed consideration of the origin, characteristics, and treatment of industrial wastewater; the theory and application of unit operations unique to the treatment and disposal of industrial wastes. Prerequisite: Civil Engineering 744. 4 lec/4 cr.

## **857. ADVANCED WASTEWATER TREATMENT**

Theory, application, and evaluation of new processes and developing techniques in water and wastewater reclamation and reuse. Prerequisite: Civil Engineering 746. 4 lec/4 cr.

## **858. ADVANCED WASTEWATER SYSTEMS DESIGN**

A formal design to solve a practical problem in wastewater treatment; field data will be gathered, a laboratory-scale unit run, and a design submitted based upon the experimental findings. Prerequisites: Civil Engineering 746 and 856. 2 lec/2 lab/4 cr.

## **864. ADVANCED SOIL MECHANICS II**

The physical and mechanical properties of soil in relation to engineering structures. The theory of consolidation, sharing resistance, bearing capacity, settlement, slope stability, earth pressure, and seepage studies. Consent of instructor required for class admission. 4 lec/4 cr.

## **865. SOILS ENGINEERING**

Application of soil-mechanics' principles to the selection of the type of substructure and the development of its bearing capacity, based on the theories of stability analysis and consolidation. Earth-pressure load determinations by various active and passive earth-pressure theories. Earth dam and foundation construction methods. Prerequisite: Civil Engineering 863 or equivalent. 4 lec/4 cr.

## **866. SOIL TESTING FOR ENGINEERING PURPOSES**

The essential tests for the physical properties: permeability, capillarity, compressibility, rate and magnitude of consolidation, and shearing resistance. Prerequisite: Civil Engineering 863 or equivalent. 2-4 cr.

## Earth Sciences

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### 867. SOIL DYNAMICS

Vibrations of elementary systems, wave propagation, elastic waves in layered systems, behavior of dynamically loaded soils, vibrations of foundations, isolation of footings, field measurements and instrumentation, design procedures for dynamically loaded foundation. Prerequisites: Civil Engineering 765 and Civil Engineering 863. 2 lec/2 cr.

### 881. ADVANCED STRUCTURAL ANALYSIS I

Advanced structural theory and analysis, including multistory structures, beam columns, frames with variable moment of inertia, continuous trusses and bents, arches and curved frames, stiff rings, and closed frames. 4 lec/4 cr.

### 882. ADVANCED STRUCTURAL ANALYSIS II

Advanced treatment, including flexible and axially loaded flexural members, beams with variable cross-section subject to axial loads, suspension bridges and flexible arches, and torsional problems of noncircular sections. 4 lec/4 cr.

### 883. STRUCTURAL STABILITY

Study of the elastic and inelastic buckling behavior of structures. Topics include: stability of columns, mathematical treatment of buckling problems and buckling criteria, lateral stability of beams, buckling of trusses and framed structures, and stability of rings and curved beams. 4 lec/4 cr.

### 884. DYNAMICS OF STRUCTURES

Analysis of structures subjected to dynamic loadings. Free and forced vibrations with one or multi-degrees of freedom. Effects of damping and inelastic action. Vibrations of beams and framed structures. Dynamic response of beams due to moving loads. 4 lec/4 cr.

### 885. APPLICATION OF SYSTEM THEORY TO STRUCTURAL ANALYSIS

Comprehensive development of the stiffness matrix of structures. Intuitive concepts of topology and linear graphs and their application to structural frameworks. Analysis of structures using linear graphs. 4 lec/4 cr.

### 886. FACILITY PROJECT ENGINEERING

A critical review of the approaches to the planning and decision processes of facilities, including: codes and specifications, concepts of engineering economy, index numbers and cost estimation procedures (including an introduction to their statistical basis) mathematical modeling concepts, and the development of design loads and criteria for specific application. 4 lec/4 cr.

### 887. APPLICATION OF LINEAR GRAPHS TO CIVIL ENGINEERING

Concepts of topology and linear graphs and their application to civil engineering planning of transportation, water and sewage distribution, and other networks. Network planning and management systems, including Project Evaluation Review Technique (PERT), Critical Path Methods (CPM), and PERT/cost procedures. 4 lec/4 cr.

### 890. TOPICS IN STRUCTURES

Studies of topics of special interest and need of the student in structural design, analysis, and optimization. 2-4 cr.

### 895, 896, 897. CIVIL ENGINEERING PROBLEMS

The study and investigation of problems selected to meet the needs of the students. 2-4 cr.

### 899. MASTER'S THESIS

Hours and cr., 6-9, to be arranged.

## Earth Sciences (49)

**Chairman:** Herbert Tischler

**PROFESSORS:** Cecil J. Schnee, Herbert Tischler

**ASSOCIATE PROFESSORS:** Franz E. Anderson, Wallace A. Bothner, Henri E. Gaudette, Glenn W. Stewart

**ASSISTANT PROFESSORS:** Francis S. Birch, Wendell S. Brown, Theodore C. Loder, Paul A. Mayewski

**COORDINATOR OF GRADUATE PROGRAM:** Henri E. Gaudette

The Department of Earth Sciences offers graduate work leading to the degree of Master of Science. Several options are available within the earth sciences program, including geochemistry; igneous and metamorphic petrology; crystallography; and chemical, physical, and geological oceanography. A student is expected to have adequate preparation in mathematics and the basic sciences. Students lacking these requirements may be admitted but will be required to complete certain courses which do not give graduate credit. In applying for admission to the departmental program, it is recommended that students submit their Graduate Record Examination scores. A candidate for the master's degree shall pass an oral or written examination covering graduate courses and thesis.

### 725. IGNEOUS AND METAMORPHIC PETROLOGY

Textural, mineralogical, and chemical analysis, and phase rule and phase diagram interpretation applied to petrogenesis. Prerequisite: E.S. 613, 614, or permission of instructor. 3 lec/1 lab/4 cr.

## 732. GEOLOGIC MAPPING AND INTERPRETATION

Standard methods of geologic field mapping; interpretation of geologic maps and aerial photographs of selected areas. Course includes field mapping excursions to local areas and an 8-10 day exercise in a selected area of the Appalachian Mountains. \$60 lab fee includes transportation and housing in the field. Prerequisite: permission of instructor. 1 lec/1 lab/4 cr.

## 734. APPLIED GEOPHYSICS

Gravity, magnetic, seismic, electrical, and thermal methods of investigating subsurface geology. Practical fieldwork and use of computers in data analysis. Prerequisite: Math 428 passed or taken concurrently, E.S. 401, and one year of college physics; or permission of instructor. 3 lec/1 lab/4 cr.

## 741. GEOCHEMISTRY

Thermodynamics applied to geological processes; geochemical differentiation of the earth; the principles and processes which control the distribution and migration of elements in geological environments. 3 lec/1 lab/4 cr.

## 752. CHEMICAL OCEANOGRAPHY

Water structure, chemical composition and equilibrium models, gas exchange, biological effects on chemistry, trace metals, and analytical methods. Laboratory includes short cruise aboard R/V Jere A. Chase. Prerequisite: permission of instructor. 3 lec/1 lab (optional)/3 or 4 cr.

## 754. SEDIMENTATION-STRATIGRAPHY

*Sedimentation*: weathering, transportation, and deposition of modern sediments. *Stratigraphy*: classification of sedimentary rocks and principles of stratigraphic correlation. 2 lec/1 lab/4 cr.

## 758. INTRODUCTION TO PHYSICAL OCEANOGRAPHY

Ocean basins; physical properties of seawater; atmosphere-ocean interaction; general ocean circulation; waves, tides, tsunamis, and gulf stream; continental shelf and near shore processes; instrumentation and methods used in ocean research. Simplified physical and mathematical models demonstrate the important concepts. Prerequisites: Physics 408, E.S. 501 or permission of the instructor. 3 lec/1 lab and field projects/4 cr.

## 759. GEOLOGICAL OCEANOGRAPHY

Major geological features and processes of the ocean floor; geological and geophysical methods; plate tectonics. Prerequisite: E.S. 401, 501 or permission of instructor. 3 lec/4 cr.

## 781. PHYSICAL GEOLOGY

Materials and structures of the earth and erosive agents that modify them. Laboratory and field trips. For certified elementary or high school science teachers who need an introduction to the earth sciences. (Not available for credit after completing E.S. 401 or equivalent.) 4 cr.

## 782. HISTORICAL GEOLOGY

Evolution of physical features and life on the earth. Fossil organisms; methods of historical geology; laboratory and field trips. Prerequisite: E.S. 781 or equivalent. For certified elementary or high school science teachers who need an introduction to the earth sciences. (Not available for credit after completing E.S. 402 or equivalent.) 4 cr.

## 795. GEOLOGICAL PROBLEMS:

1) Areal Geology, 2) Geochemistry, 3) Geomorphology, Advanced, 4) Geophysics, 5) Glacial Geology, Advanced, 6) Groundwater Geology, 7) Historical Geology, Advanced, 8) Industrial Minerals, 9) Micropaleontology, 10) Mineral Fuels, 11) Mineralogy, Advanced, 12) Optical Crystallography, 13) Ore Deposits, 14) Paleontology, Advanced, 15) Petrology, Advanced, 16) Regional Geology, 17) Sedimentation, 18) Stratigraphy, 19) Structural Geology, Advanced, 20) Marine Geology, 21) Physical Oceanography, 22) History of Geology, 23) Earth Science Teaching Methods, 24) Senior Synthesis, 25) Chemical Oceanography.

Special problems by means of conferences, assigned readings, and field or laboratory work, fitted to individual needs from one of the areas listed above. Staff. 2 or 4 cr.

## 796. HONORS PROJECT

Independent research projects similar to E.S. 795 for students with 3.0, or better, average in Earth Sciences. 2 or 4 cr.

## 797. GEOLOGY COLLOQUIUM

Study of selected topics in both classical and modern geological thought. For majors. 0 cr. Cr/F.

## 813. X-RAY CRYSTALLOGRAPHY

Theory and practice of diffraction of X-rays by crystals; lattices, symmetry, and structure analysis. Prerequisite: E.S. 613, Mineralogy, or Physical Chemistry or equivalent. 3 cr.

## 816. MINERALOGY OF CLAYS

Mineralogic composition of clays; the structure and properties of the clay minerals; origin and mode of occurrence of the clay minerals and clay materials. Prerequisite: permission of instructor. 3 cr.

## Economics

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### 820. ADVANCED IGNEOUS PETROLOGY

Extensive readings and discussions of original sources and recent literature with reference to classical petrologic provinces. Application of thermodynamics and phase-rule chemistry to igneous petrogenesis. Prerequisite: graduate standing and permission of instructor. 3 cr.

### 821. ADVANCED METAMORPHIC PETROLOGY

Extensive readings and discussions of original sources and recent literature dealing with the facies concept, equilibrium reactions, reaction kinetics, and other chemical aspects of metamorphic petrogenesis. Prerequisite: graduate standing and permission of instructor. 3 cr.

### 841. ANALYTICAL GEOCHEMISTRY

Introduction to the theory, instrumentation, and applications of analytical methods in Geochemistry. Prerequisite: permission of the instructor. 3 cr.

### 856. ESTUARINE AND MARINE SEDIMENTATION

Unique aspects of sedimentation in marine and brackish water environments with special emphasis placed on factors controlling deposition of coastal and shelf areas. Deep sea marine sediment will be examined primarily for non-biogenic components. Course includes completion of a project and preparation of a report suitable for publication. Prerequisite: permission of instructor. 3 cr.

### 858. DYNAMICAL OCEANOGRAPHY

The hydrodynamics of ocean phenomena will be treated in detail. Topics include surface, internal and planetary waves; tides and oceanic turbulence; wind driven circulation; continental shelf and near shore processes. Prerequisite: E.S. 758, M.E. 707 or permission of the instructor. 3 lec/4 cr.

### 895, 896. TOPICS IN GEOLOGY

Advanced work on an individual or group basis under members of the graduate staff. Prerequisite: permission of department chairman and staff concerned. 1-4 cr. May be taken more than once. Sections of this course are the same as those listed under Earth Sciences 795.

### 897, 898. SEMINAR IN CONTEMPORARY GEOLOGY

A review and discussion of recent geological literature. Required of graduate students in Earth Sciences. Staff. 1-3 cr.

### 899. EARTH SCIENCES MASTER'S THESIS

6-10 cr.

## Economics (31)

**Director of Graduate Studies:** Kenneth J. Rothwell

**PROFESSORS:** Robert F. Barlow, Manley R. Irwin, John J. Korbel, Samuel R. Reid, Sam Rosen, Kenneth J. Rothwell, Dwayne E. Wrightsman

**ASSOCIATE PROFESSORS:** George W. Betz, Allan J. Braff, William R. Hosek, Richard L. Mills, Lawrence P. Nordell, Robert C. Puth

**ADJUNCT ASSOCIATE PROFESSOR:** James A. Smith

**ASSISTANT PROFESSORS:** Lawrence P. Cole, Philippe DeVille, Richard Hurd, Heidemarie C. Sherman, Allen R. Thompson

## Whittemore School of Business and Economics

The economics faculty of the Whittemore School together with the resource economics faculty of the Institute of Natural and Environmental Resources offers a program leading to the degree of Doctor of Philosophy. In addition, the economics faculty offers a plan of study culminating in the degree of Master of Arts.

## Doctor of Philosophy Degree

Admission to this program is open to students whose undergraduate work shows evidence of superior ability and motivation and who manifest promise of serious scholarship. Normally, the appropriate undergraduate preparation will include exposure to economic reasoning and methodology, including mathematics and statistics. Those who warrant special consideration, even though their backgrounds are deficient, should be aware that remedial work may be required.

Admission requirements in addition to those established by the Graduate School include: the Graduate Record Examinations (aptitude and advanced test in economics); T.O.E.F.L. for applicants from non-English speaking countries; three letters of recommendation from those acquainted with the applicant's past academic performance, of which two shall be from those familiar with the applicant's work in his/her major.

The Ph.D. candidate after admission will be required to demonstrate proficiency in two research tools: 1) a reading knowledge in one foreign language which contains a substantial body of formal economics or is appropriate to an economic research field and 2) demonstrated competence in differential and integral calculus and linear algebra as applied to quantitative economics.

Ph.D. candidacy requires written evidence of proficiency in Economic Theory (including the Evolution of Economic Analysis and Quantitative Economics) and in three other fields of economics (or two in economics and one approved related field). Successful exami-



nation in Economic Theory is to precede the qualifying examination in other fields. In special cases, oral examinations may be required. The dissertation will be followed by an oral defense.

For the present, dissertations are confined to the following topics/fields: International Economics; Economic Development; Labor and Manpower Economics; Industrial Organization; Monetary and Financial Economics and Regional Economics. Details of the doctoral program can be obtained from the director of graduate economic studies.

## Master of Arts Degree

Admission to graduate study leading to the degree of Master of Arts is limited to students with a better than average undergraduate record. Candidates for admission are required to take the Graduate Record Examination (both the Aptitude Test and Advanced Test in Economics). The prerequisite for graduate work consists of a minimum of 12 hours of undergraduate study in economics and 12 hours in related fields. In addition, all candidates must either present six hours of undergraduate credit in statistics or mathematics, or take six hours of undergraduate work in statistics or mathematics at the University of New Hampshire without credit, or pass a proficiency test in either field.

The candidate for a master's degree may take a general course of study or the thesis option. The general requirements of the Graduate School and the following major requirements must be met:

- 1) 32 semester hours of graduate study which may include 8 hours of thesis work;
- 2) Minimum of 24 semester hours in courses numbered 700 and above and at least 12 hours in courses numbered 800 and above apart from Economics 899, Thesis;
- 3) Maximum of 8 semester hours in approved courses numbered 600 and above taken in related disciplines;
- 4) A course grade of B or better at the graduate level as evidence of proficiency in both micro- and macro-economic analysis;
- 5) Evidence of proficiency, based upon a comprehensive written examination in one of the following fields: Labor and Manpower, Monetary and Financial Economics, Regional Economics, Economic History, Quantitative Analysis, Community Development, Economic Development, Industrial Organization, Public Finance and Fiscal Policy, Resource Economics, International Economics.

### 711. ECONOMIC FLUCTUATIONS

Recurrent movements of prosperity and depression; emphasis on causes and public-policy implications. Prerequisite: Econ. 611 or permission of instructor. 4 cr.

### 720. U.S. ECONOMIC HISTORY

From Colonial times to the present. Applied economic theory;

economic models and interpretation of data. Influence of technology, industrialization, foreign trade, monetary factors, and government; non-economic factors. Prerequisite: Econ. 605, 611; or consent of instructor. 4 cr.

### 721. EUROPEAN ECONOMIC HISTORY

Western European and Mediterranean economies from medieval times to the Common Market. Economic models and interpretation of data. Capital accumulation, technology, trade, industrialization, monetary factors, and the role of government; relevant non-economic factors. Prerequisite: Econ. 605, 611, or consent of instructor. 4 cr.

### 722. CASE STUDIES IN ECONOMIC DEVELOPMENT

Problems and policies in selected countries; evaluations of national plans, programs, and projects; comparative analysis. Sections: 1 Southeast Asia; 2 Cost-Benefit and Project Analysis; 3 Africa; 4 South America. Prerequisites: Econ. 401, 402; or consent of instructor. 4 cr.

### 725. STATISTICAL THEORY

Univariate and bivariate mathematical statistics; i.e., probability theory, discrete and continuous random variables and their distributions, moments and moment-generating functions, parameter estimation, hypothesis testing, correlation and regression analysis, analysis of variance. Prerequisites: Math 427-428 or equivalent. 4 cr.

### 726. MATHEMATICAL ECONOMICS

Principal mathematical techniques and their application in economics. Prerequisite: permission of instructors. 4 cr.

### 727. INTRODUCTION TO ECONOMETRICS

Economic phenomena in mathematical terms; models of economic activity and derivation of propositions which are subject to statistical test, primarily by means of multivariate regression analysis. Prerequisite: Econ. 725 or permission of instructor. 4 cr.

### 746. INTERNATIONAL FINANCE

International monetary mechanism; balance of payments; international investment; exchange rates, adjustment systems, international liquidity, foreign aid, multinational corporations. Prerequisite: Econ. 401, 402. 4 cr.

### 758. MANPOWER AND EDUCATION PLANNING

Flows of human beings within and between the educational and manpower sectors of the economy, also related to flows of goods and services in the industrial sector. Interrelationships

# Economics

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of these flows; construction of a computer simulation-model tracing the impact throughout the economy of manpower and educational-planning decisions. Prerequisite: Econ. 401, 402; or consent of instructor. 4 cr.

## **761. NATIONAL ECONOMIC PLANNING**

Planning in a market economy: the new industrial state. Planning as a substitute for markets: the developing countries. Planning as a way of transforming society; socialist economies; techniques of planning social and political issues related to various planning methods. Prerequisite: Econ. 605, 611; or consent of instructor. 4 cr.

## **768. SURVEY OF URBAN ECONOMICS**

Theoretical and empirical bases; policy alternatives for the problems of poverty, housing, urban renewal, transportation, local fiscal affairs, and pollution. Prerequisite: Econ. 605 or permission of instructor. 4 cr.

## **798. SEMINAR IN ECONOMIC PROBLEMS**

Special topics; may be repeated. Prerequisite: consent of adviser and instructor. 2 or 4 cr.

## **855. COLLECTIVE BARGAINING**

Explores the historical development of the U.S. labor movement and the industrial relations system. Contemporary collective bargaining issues are discussed and the role of public policy in industrial relations is examined. 4 cr.

## **856. LABOR ECONOMICS**

Recent developments in labor market analysis and public policies related to contemporary labor issues are discussed. Topics covered include labor supply, the structure and stratification of labor markets, economic discrimination, unemployment and poverty, inflation, and wage-price controls. 4 cr.

## **857-858. HISTORY OF ECONOMIC THOUGHT**

The evolution of economic thought. Examination and critical appraisal of the work of major economists and major schools of economists. 4 cr.

## **859. GOVERNMENT REGULATION OF BUSINESS**

Analysis of government policy with reference to such problems as conspiracy, monopoly, mergers, unfair practices, and discrimination. This analysis includes a legal and economic appraisal of government policy alternatives. 4 cr.

## **860. SEMINAR IN INDUSTRIAL ORGANIZATION AND PUBLIC POLICY**

An examination of historical and contemporary developments in the theoretical and applied areas of industrial and commercial market structures, behavior and performance. Prerequisite: permission of instructor. 4 cr.

## **863. INTERNATIONAL ECONOMICS**

Contemporary issues in international economic theory and policy. Analysis of trade theory, dynamics of world trade and exchange, and international commercial policy. 4 cr.

## **873. MACRO-ECONOMIC THEORY I**

Advanced analysis of such aggregates as national income, total output, employment, and the general price-level. Examination of the major aggregate models. 4 cr.

## **874. MACRO-ECONOMIC THEORY II**

A continuation of Macro-economic Theory I in which the dynamics of the models are stressed and growth theory receives central attention. Prerequisite: Economics 873. 4 cr.

## **877. MICRO-ECONOMIC THEORY I**

Topics in micro-economics with emphasis on recent developments in such areas as general equilibrium analysis, welfare economics, demand theory, and capital theory. 4 cr.

## **878. MICRO-ECONOMIC THEORY II**

A continuation of Micro-economic Theory I. The course will attempt to bring the student to the frontiers of contemporary research on selected problems of micro-economics. Prerequisite: Econ. 877. 4 cr.

## **890. ECONOMICS OF FINANCIAL MARKETS**

Economic analysis of financial market systems. Topics include financial market functions, theories of saving and investment, financial intermediation, flow-of-funds analysis, loanable funds theory, interest rate forecasting, portfolio theory, capital asset pricing models, structure of interest rates (including term structure theory), and macroeconomic models of the financial sector. 4 cr.

## **891. SEMINAR IN MONETARY THEORY AND POLICY**

Contemporary developments in monetary theory and the evaluation of policy measures. 4 cr.

## **892. SEMINAR IN PUBLIC FINANCE—THEORY AND POLICY**

Selected topics in contemporary theoretical and policy problems of public finance. 4 cr.

### 894. SEMINAR IN ECONOMIC DEVELOPMENT

A survey of the theories of the development process and an examination of the role of various forces of economic change in developing countries. 4 cr.

### 895-896. INDEPENDENT STUDY

Selected projects. Staff. 8 cr.

### 899. THESIS

Staff. 8 cr.

### 999. DOCTORAL RESEARCH

Staff.

## Education (61)

**Chairman:** Gerald J. Pine

**PROFESSORS:** Angelo V. Boy, Roland B. Kimball, Carleton P. Menge, Gerald J. Pine

**ASSOCIATE PROFESSORS:** Michael D. Andrew, Charles H. Ashley, Jason E. Boynton, John G. Chaltas, David D. Draves, Edward D. Durnall, David J. Hebert, Bud B. Khleif, Joseph J. Petroski, M. Daniel Smith, Deborah E. Stone, Dwight Webb

**ASSISTANT PROFESSORS:** Margaret D. Ackerman, Virginia Bereit, John Carney, Ellen Corcoran, Ronald P. Curcio, Michael Diamonti, Anne Diller, Sidney Eder, Donald H. Graves, Edward J. Lawton, Stephen T. Murphy.

**ADJUNCT PROFESSORS:** Donald D. Durrell, Frederick Jervis

**ADJUNCT ASSISTANT PROFESSORS:** John R. Cavanaugh, Peter Cimbalic

**GRADUATE COORDINATOR:** David J. Hebert

### Admission to Graduate Standing

Admission to graduate standing in the Department of Education is granted to applicants meeting the entrance requirements of the Graduate School and accepted by the department. Applications must include Graduate Record Examination scores for the aptitude test.

### Admission Requirements

1) Above average academic credentials; 2) above average scores on the Graduate Record Examination; 3) three strongly supportive letters of recommendation attesting to intellectual and personal competence from persons in a position to judge the applicant's preparation and fitness for graduate work; 4) applicants for the Certificate

of Advanced Graduate Study must meet the preceding admission requirements and also possess a master's degree in an appropriate specialty.

### Admission Procedures

1) File an application for admission to Graduate School. This application is available directly from the dean of the Graduate School, Social Science Center, University of New Hampshire, Durham, New Hampshire 03824.

2) Transcripts, letters of recommendation, and Graduate Record Examination scores should be sent directly to the dean of the Graduate School.

3) Scores must be submitted for the aptitude tests of the nationally administered Graduate Record Examination. Information regarding the Graduate Record Examination may be obtained by contacting either Educational Testing Services in Princeton, New Jersey, or the Counseling and Testing Center at the University of New Hampshire.

4) Completed applications are reviewed by the education department's Admissions Committee which makes a recommendation on admission to the dean of the Graduate School. The applicant is informed of the final decision regarding the application by the dean.

### Thesis or Comprehensive Examination

Candidates in the Master of Education program ordinarily will be expected to complete a research thesis, a written comprehensive examination, a set of professional statements with an oral examination, or a clinical experience. Each candidate will plan this portion of the program in terms of his/her own professional needs and in consultation with the graduate adviser. There is no thesis or examination requirement for the Master of Arts in Teaching.

Courses are not always offered in sequence; consult the time and room schedule for current offerings.

## Master's Degree Programs in Education

The Department of Education and the Graduate School offer courses in six graduate programs which lead to the Master of Education degree. Some of these programs are also available to part-time students through the Division of Continuing Education.

Areas of specialization include the following: administration and supervision, counseling and personnel services, early childhood education, elementary education, reading, and secondary education.

# Education

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## Educational Administration and Supervision

**Program Information:** Charles Ashley, J. Boynton, Roland Kimball, and Joseph Petroski.

The program is designed for the experienced teacher who seeks to become qualified in the broad area of supervision and administration, grades K-12. Emphasis is placed on the elementary and secondary school principalship and general instructional supervision.

**Required Education Courses** (24 credits): 785, Tests and Measurements; 865, Educational Supervision; 853, Seminar in Curriculum Study; 861, Public School Administration; 863, Seminar in Educational Administration; and 869, Practicum in Educational Administration.

**Electives** (12 credits): The pattern of electives is to be planned with each student in view of the student's background and professional objective. Normally a major portion will be selected from the following education courses: 864, Personnel and Communication in Educational Organizations; 884, Advanced Human Development; 883, Advanced Psychology of Human Learning; 886, Philosophy of Education; 895, Independent Study in Education; 797, Seminar in Contemporary Educational Problems; 888, Sociology of Education; and from Bus. Adm. 803, Human Behavior in Organizations; Bus. Adm. 713, Interpersonal and Group Dynamics; Sociology 740, Culture Change; and Sociology 770, Culture, Personality, and Society.

**Oral Examination:** The program will conclude with a comprehensive oral examination based upon the thesis prepared by the candidate or with a major research study dealing with a problem in school administration, curriculum, or educational supervision.

## Counseling and Personnel Services

**Program Information:** Angelo Boy, Peter Cimboric, David Hebert, Stephen Murphy, Gerald Pine, and Dwight Webb.

The program provides the graduate with the entry credentials of a professional counselor who is able to:

- 1) Provide behaviorally relevant individual and group counseling relationships;
- 2) Function as a scholar-practitioner by developing a sophisticated interplay between counseling theory and practice, whereby each expands and enhances the other; and
- 3) Function in any setting dedicated to the educational, vocational, social, and psychological emergence of the person.

Degree candidates must successfully complete one of the following: written examination, oral examination, or research thesis.

**Required Education Courses:** (20 credits): 820, Counseling Theory and Practice; 821, Psychology of Vocational Development; 822, Psychological Tests in Personnel Services; 823, Group Counseling; and 826, Practicum in Counseling.

**Electives** (12 credits): Elective courses available within the counseling program are Laboratory in Counseling, and Counseling

and Guidance in the Elementary School. Other graduate-level elective courses are available from any department or school in the University with offerings related to the behavioral sciences.

## Early Childhood

**Program Information:** Donald Graves, Deborah Stone.

The master's program in early childhood is a 12-month program (July through June) with the objective of preparing participants as early childhood resource specialists. Upon completion of the program it is expected that one has the competence to assume a role as master teacher, supervisor of an early childhood program, curriculum consultant, in-service teacher-educator, or college level instructor in early childhood.

This graduate program is characterized by an emphasis upon the practicum experience coordinated with extensive course work in the academic disciplines.

Participants engage in an intensive summer experience devoted to study of the young child and an analysis of the learning environment appropriate for that child. From September through June the graduate students are completely responsible for setting up and staffing early learning centers in local school districts in which they work in a co-teaching situation with another participant in the program as well as with volunteer aids from the local community.

Throughout the school year participants engage in course work and seminars concurrent with the practicum experiences by returning to the campus one week per month for study (on alternate weeks for each team partner) and through taking part in frequent Saturday seminars. Additional field experiences are: visits to Toronto, Canada, schools; to Follow Through models; to Montessori Schools; as well as three-week work experience in British Infants Schools in England.

The production of a monthly early childhood newsletter is a responsibility of those engaged in the program, the provision of staff development workshops for local school personnel is expected, and the year culminates with the students' participation in the planning and execution of an early childhood conference at the New England Center for Continuing Education.

In this thirty-six credit program, in addition to the continuous active involvement in an early childhood learning center, regular newsletter contribution, and conference participation, an independent study is a required part of each semester's program. It is anticipated that the independent study will result in papers of significance which will be shared at the early childhood conference.

## Elementary and Secondary Education

**Program Information:** Teacher Education Committee: Michael Andrew, Charles Ashley, John Chaltas, Ellen Corcoran, Ann Diller, Carleton Menge.

This program is designed primarily for the elementary or secondary classroom teacher. Prerequisites: Fulfillment of admissions requirements of the Graduate School and acceptance by the Department of Education.

The total requirement is for a minimum of 30 credits, with at least 12 credits being selected from the core curriculum in consultation with the student's adviser and with his/her approval.

**Core Curriculum:** Education 785, Tests and Measurements; 838, Sociology of Education: Social Organization of Schools and Community; 853, Seminar in Curriculum Study; 883, Advanced Psychology of Human Learning; 884, Advanced Human Development; 886, Philosophy of Education.

**Electives** (10-18 credits): Electives are to be selected in consultation with the student's adviser and with his/her approval. They may be taken in specialized areas from within the Department of Education, in the student's major field, or in some combination of the two.

**Concluding Experience:** There are three options for the concluding experience: 1) One may take 30 credits and present a set of theses on which an oral examination is to be taken and satisfactorily passed. 2) One may do a research thesis, taking at least 22 credits from the above; 4 credits in Education 881, Methods and Techniques of Educational Research; and 6 credits in 899, Thesis. 3) One may, with the approval of one's adviser, taken the 30 hours and a written comprehensive examination.

### Reading

**Program Information:** John Carney

The program for the Master of Education degree with a specialization in Reading Education is designed to provide the professional preparation required of the reading specialist. The student will concentrate on the two aspects of the reading program which are consistent with the aims of such services: 1) the improvement of reading abilities of all children; 2) the prevention, diagnosis and remediation of reading difficulties.

Within the scope of the program, the following requirements will be satisfied: standards for the professional training of reading specialists recommended by the International Reading Association; and certification requirements for the reading specialist set forth by the New Hampshire State Department of Education.

The specific program will be planned, with the assistance of the student's adviser, to meet individual needs as indicated by the academic and professional background and his/her professional objectives.

**Core Curriculum** (28 credits): Education 807, Foundations of Reading Instruction; 808, Diagnosis of Reading Difficulties; 809, Remediation of Reading Difficulties; 810, Comprehensive Reading Methods in the Secondary School; 813, Field Practicum in Reading; 814, Seminar in Reading. Choose one of the following: Education 811,

Clinical Experience in Reading—Elementary; or 812, Clinical Experience in Reading—Secondary.

**Electives** (8 credits): The remainder of courses are selected in consultation with the adviser. They may be from the offerings of the Department of Education or reflect an interdisciplinary approach with other graduate departments at the University.

**Concluding Requirements:** 1) Completion of 36 credits: Written comprehensive or theses with oral examination. 2) Completion of core curriculum (28 credits): 8 credits thesis, or 4 credits 881 and 6 credits thesis.

### Master of Arts in Teaching and Master of Education Degrees for Preservice Teachers

**Program Information:** Michael Andrew, coordinator of Teacher Education.

The Department of Education offers two masters' degrees for students completing the teacher preparation program at UNH. Students may enter the teacher education program as undergraduates, thus satisfying some of the requirements for certification prior to master's level work. The programs are also open to people who have completed an undergraduate program with no work in education and to people who have finished college some time ago. Specialization is available at the primary, middle school, and high school levels. Students entering these master's degree programs with have completed a bachelor's degree program with a major outside the field of education.

All professional education requirements for certification must be met either prior to or as part of the master's degree programs for preservice teachers. These professional requirements include Education 500, Exploring Teaching or equivalent, and each of the following education courses: 700, Educational Structure and Change; 701, Human Learning and Development; 703, Alternative Teaching Models; 705, Alternative Perspectives on the Nature of Education; and 801-802, Internship (12 credits). (In some cases 6 credits of internship may be allowed.)

Additional requirements for elementary school teaching are one course in elementary school reading and two courses in mathematics appropriate for elementary school teaching.

#### Master of Arts in Teaching (Elementary & Secondary)

All candidates must complete, or have completed prior to admission, a one-semester teacher aide experience or its equivalent with supportive recommendation from school staff. Education 500, Exploring Teaching, may be taken by UNH undergraduates. Other candidates will enroll in the experimental summer school program (Ed. 831 or 835) which will satisfy this requirement.

# Education

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## Degree Requirements:

1) Twelve graduate credits outside the Department of Education (One of required math courses may be included in these 12 credits for elementary MATs.)

2) Twelve credits of Internship: Education 800 (6 credits) and Education 801 (6 credits). Six credits of internship may be approved for some MAT candidates who have had Education 831, 835, or equivalent classroom experience.

3) Graduate electives inside or outside the Department of Education (Credits in Education 700, 701, 703, and 705 may be counted as electives.)

4) Minimum of 30 credits.

5) Final experience: theses (professional statements and oral examination), research thesis, or project. All these options will be administered and approved by a committee of at least three faculty, chaired by the student's adviser. Theses and project options will not be taken for credit. Research thesis option requires Education 899, Thesis (4 credits) and Education 881, Research Problems in Education required for students who have not had advanced research course, (4 credits). These 8 credits may be counted toward the 12 credits of graduate specialization in education.

## Master of Education for Preservice Teachers (Elementary and Secondary)

All candidates must complete, or have completed prior to admission, a one-semester teacher aide experience or its equivalent with supportive recommendation from school staff, (Education 831 or 835) which will satisfy this requirement.

### Degree Requirements:

1) Twelve graduate credits in education. Credits may be counted from Education 700, 701, 703, and 705 beyond the minimum requirements of 4 credits in each area; the required elementary reading course may be counted in the 12 hours for prospective elementary teachers. Twelve-hour specializations will be available in a number of areas including the following: reading, counseling, curriculum and instruction, and developmental disabilities.

2) Twelve credits of internship: Education 800, (6 credits) and Education 801 (6 credits). (Six credits of internship may be approved for some M.Ed. candidates who have had Education 831, 835, or equivalent classroom experience.)

3) Graduate electives inside or outside the Department of Education. (Credits in Education 700, 701, 703, and 705 may be counted as electives.)

4) Minimum total is 30 credits.

5) Final experience: theses (professional statements and oral examination), research thesis, or project. All of these options will be administered and approved by a committee of at least three faculty, chaired by the student's adviser. Theses and project options will not be taken for credit. Research thesis option requires Educa-

tion 899, Thesis (6 credits), and Education 881, Research Problems in Education (4 credits), for students who have not had an advanced research course. These 10 credits may be counted toward the 12 credits of graduate specialization in education.

Students entering the MAT or M.Ed. programs with none of their professional requirements previously met will generally follow the program format listed below.

First Summer: Summer school teaching and seminars, 10 credits; 8 credits in Education 831 or Education 835; and 2 credits in Education 700. (Satisfies requirement for Education 500, Education 703, and 2 credits of Education 700.)

Academic Year: Internship (6 or 12 credits) plus varying number of credits in professional requirements and courses in area of graduate specialization.

Second Summer: Balance of degree requirements.

## Certificate of Advanced Graduate Study

A Certificate of Advanced Graduate Study (CAGS) is available in two programs: Counseling, and School Administration and Supervision.

### Counseling (CAGS)

This program is designed for those who possess a master's degree in Counseling or an equivalent master's degree and want to pursue further study toward the Certificate of Advanced Graduate Study. The candidate for this Certificate must successfully complete 32 graduate credits beyond the master's degree, and one of the following before graduation: written examination, oral examination, or research thesis.

**Required Education Courses** (20 credits): 827, Organization and Administration of Personnel Services; 828, Advanced Counseling Theory and Practice; 829, Advanced Practicum in Counseling; 830, Research in Personnel Services; and 884, Advanced Psychology of Human Development.

**Electives** (12 credits): Elective courses available within the Counselor Education Program are: Laboratory in Counseling, and Counseling and Guidance in the Elementary School.

Other graduate-level elective courses are available from the departments of education, business administration, economics, english, history, home economics, mathematics, political science, psychology, and sociology. Contact Professor Angelo Boy, Morrill Hall, for further information.

### Educational Administration (CAGS)

The program is designed for individuals who possess a master's degree or graduate study equivalent to that outlined in the Univer-

sity of New Hampshire M.Ed. program in Educational Administration and Supervision and who wish advanced preparation for careers as school superintendents, assistant superintendents, business managers, state department of education personnel, vocational education coordinators, curriculum coordinators, or educational personnel in private organizations.

Applicants for admission must meet the selection criteria established by the University of New Hampshire Graduate School and Department of Education.

A candidate in this program must complete a significant field project of 12 semester hours within the administrative environment in which the person intends to function. Eight semester hours are required in instructional leadership; eight semester hours are required in management and administration. Twelve semester hours include electives outside the Department of Education.

The program is based upon the following:

1) Students in this program pursue basic courses in educational administration and supervision as well as electives which will enable them to function more adequately within a specific administrative environment.

2) Because of the complex role of the school administrator, persons seeking preparation as administrators must demonstrate intellectual and personal competence of superior quality.

3) The graduate program for administrators will emphasize the ability to apply the relevant facts and formulations derived from administrative theory and research in the solution of significant operational problems.

Contact Charles Ashley, Associate Professor of Education, Morrill Hall, for further details regarding the Certificate of Advanced Graduate Study in Educational Administration and Supervision.

## **(700) 700. EDUCATIONAL STRUCTURE AND CHANGE**

Organization, structure, and function of American schools; processes of change in education; how successful innovation is accomplished. Field experience options. Variable-credit modules. Sections listed in Department prior to preregistration. Prerequisite: Ed. 500 or permission of instructor. Minimum of 4 cr. required for teacher certification. Variable 1-4 cr.

## **(701) 701. HUMAN LEARNING AND DEVELOPMENT**

Individual development; learning process analysis. Variable-credit modules on the theories, research, and implications of a specific topic offered each semester and summer. Sections listed in Department prior to preregistration. Prerequisite: Ed. 500 or permission of instructor. Minimum of 4 cr. required for teacher certification. Variable 1-4 cr.

## **(703) 703. ALTERNATIVE TEACHING MODELS**

Analysis and application of basic teaching models and techniques

(from very teacher-directed to very student-centered). Observation of master classroom teachers and exemplary videotapes; service as aides to master-teachers; seminars. Techniques and analysis systems through observation of videotapes, micro-teaching, completion of appropriate self-instruction units, and seminars. Variable credit modules; sections listed in department prior to preregistration. Prerequisite: Ed. 500 or permission of instructor. Minimum of 4 cr. required for teacher certification. Variable 1-4 cr.

## **(705) 705. ALTERNATIVE PERSPECTIVES ON THE NATURE OF EDUCATION**

Students formulate, develop, and evaluate their own educational principles, standards, and priorities. Alternative philosophies of education; contemporary educational issues. Variable credit modules; sections listed in department prior to preregistration. Prerequisite: Ed. 500 and departmental permission. Minimum of 4 cr. required for teacher certification. Variable 1-4 cr.

## **(706) 706. INTRODUCTION TO READING INSTRUCTION IN THE ELEMENTARY SCHOOLS**

The reading process; current procedures and materials; diagnostic techniques; clinical experience. Course satisfies reading requirement for prospective elementary teachers in the five-year teacher-education program and may be included in the 12 required graduate credits in Education at the graduate level. Course may also be taken for undergraduate credit prior to entrance into fifth year; in this case the course satisfies reading requirement but is not applicable toward the 12 required graduate credits. 4 cr.

## **(707) 707. APPROACHES TO TEACHING READING AT THE SECONDARY LEVEL**

**The Reading Curriculum in the Secondary School.** Analysis of the structural components (developmental, corrective, remedial); materials and methods of instruction and appraisal; instruments of measurement and evaluation in the comprehensive secondary reading program. 2 cr.

**Teaching Reading through the Content Areas: Alternative and Application.** Students learn new approaches, concepts, and methodologies of teaching reading; workshop to develop and produce instructional strategies and materials for an integrated reading-content program. 2 cr.

## **(734) 734. CHILDREN'S LITERATURE**

Children's books and how to use them, primarily in intermediate grades; how to correlate children's books with various special projects. 4 cr.

# Education

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## Courses in Developmental Disabilities

The education department offers several courses in developmental disabilities (Education 750, 751, 752, and 753).

### (750). SURVEY OF DEVELOPMENTAL DISABILITIES

Nature of handicaps; psychological and educational problems; causal factors; evaluation; learning potential; and general characteristics. Emphasis on mental retardation. 4 cr.

### (751). TEACHING THE DEVELOPMENTALLY DISABLED CHILD

Development of skills for children with mental retardation, physical impairments, and sensory defects. Students will teach a child with mental retardation and a child with either a physical or sensory impairment, and prepare case studies. 4 cr.

### (752). DIAGNOSIS AND REMEDIATION OF LEARNING DISABILITIES

Terminology, etiology, common characteristics, symptoms. Theory and practice in gross-motor, visual, and auditory-testing procedures used in diagnosis. Test findings for use in remediation programs. 4 cr.

### (753). TEACHING THE CHILD WITH EMOTIONAL AND SOCIAL DIFFICULTIES

Nature and scope of emotional disturbances and social maladjustment in children including causes, characteristics, and treatment programs. 2 cr.

### (763). INTRODUCTION TO EDUCATIONAL MEDIA

Educational media in the learning process; curricular integration of materials and equipment in the school library media center; design and implementation of learning systems that provide a framework for the development of individual skills. 4 cr.

### (785). EDUCATIONAL TESTS AND MEASUREMENTS

The theory and practice of educational evaluation; uses of test results in classroom teaching and student counseling; introductory statistical techniques. 4 cr.

### 795, 796. INDEPENDENT STUDY

Juniors and seniors only with approval by appropriate faculty member. 2 or 4 cr.

### (797). SEMINAR IN CONTEMPORARY EDUCATIONAL PROBLEMS

Issues and problems of special contemporary significance, usually on a subject of recent special study by the staff member(s). Prerequisite: permission of instructor(s). May be repeated for different topics. Variable 1-4 cr.

### 800-801. INTERNSHIP AND SEMINAR IN TEACHING

A two-semester, full-time, supervised internship consisting of less than full teaching responsibility in selected educational settings and programs. Weekly seminars and occasional workshops held concurrently with internship. Admission by application. 6 or 12 cr.

### 806. APPROACHES TO LANGUAGE ARTS INSTRUCTION

A study of the variety of approaches to language arts instruction. Current research and trends will be analyzed. Language development and literature will be explored, including contributions of allied disciplines such as semantics and linguistics. Focus is on the processes of communication and application to school curriculum. 4 cr.

### 807. FOUNDATIONS OF READING INSTRUCTION

A survey of the reading process, theoretical models, and basic approaches to the teaching of reading. Emphasis on current methods, materials, and programs. 4 cr.

### 808. DIAGNOSIS OF READING DIFFICULTIES

Investigation of the nature, causes, and correlates of reading disability. Study of diagnostic procedures and materials through case studies, discussions, demonstrations, and practice. Prerequisite: 807 (may be taken concurrently). 4 cr.

### 809. REMEDIATION OF READING DIFFICULTIES

Covers procedures for remediating reading deficiencies and modifications of teaching necessary to adjust to diverse reading handicaps. Emphasis on a diagnostic teaching approach to reading remediation. Prerequisites: 807 and 808 may be taken concurrently with 809. 4 cr.

### 810. COMPREHENSIVE READING METHODS IN THE SECONDARY SCHOOL

The nature of the reading process, diagnostic and developmental methods and materials, study skills, and reading in the content areas at the secondary level. Designed for secondary school teachers who wish to foster continuous development of students' reading and study skills. 4 cr.



## 811. CLINICAL EXPERIENCE IN READING—ELEMENTARY

Individual and small-group work with children will provide opportunity for clinical analysis, micro-teaching, and evaluation. Seminars will focus on the processes of reading and language and the effects of a variety of materials and methods on learning. Prerequisites: 807, 808, 809 (may be taken concurrently with 811). 4 cr.

## 812. CLINICAL EXPERIENCE IN READING—SECONDARY

Supervised tutoring of secondary school students in order to develop techniques for improving reading skills. Seminars will focus on corrective techniques and the integration of reading skills to the content areas. Prerequisites: 807, 808, 809 (may be taken concurrently with 812). 4 cr.

## 813. FIELD PRACTICUM

This phase of the program is designed to expand the student's competence in areas where the greatest need is felt. This is a highly individualized portion of the program where the student plans activities which are most useful to him. Prerequisite: permission of instructor. 4 cr.

## 814. SEMINAR IN READING

Investigation of current research findings in reading and the related language arts. Seminars will focus on significant research projects, program designs, and analysis of the field of reading research and ramifications for the reading specialist. Prerequisite: permission of instructor. 4 cr.

## 818. PRINCIPLES AND PROCEDURES IN REHABILITATION

Introductory course integrating theory and practice in the field of rehabilitation. History and philosophy of rehabilitation as a social movement, including relevant legislation. Study of institutions. Role, function, and work of the counselor. Relation of the rehabilitation process to the total health and helping service delivery systems. Prerequisite: permission of instructor. 4 cr.

## 819. SOCIAL AND PSYCHOLOGICAL ASPECTS OF DISABILITY

Examination of historical and cultural concepts of human deviance and disability. Analysis of social, psychological, and vocational factors resulting from disabling and disadvantaged human conditions. Relationship of rehabilitation to disability and to individual adjustments. Field-based consultation with disabled individuals and rehabilitation agencies. Simulated, eight-hour disability project for each student. Prerequisite: permission of instructor. 4 cr.

## 820. COUNSELING THEORY AND PRACTICE

The basic approaches to counseling are examined. Consideration is given to their theoretical foundations, process components, goals, and outcomes. 4 cr.

## 821. PSYCHOLOGY OF VOCATIONAL DEVELOPMENT

An investigation of the psychological and informational factors which influence occupational decisions and progress. 4 cr.

## 822. PSYCHOLOGICAL TESTS IN PERSONNEL SERVICES

An analysis of evaluative instruments and techniques which have particular utility in personnel services. Comparisons of sample instruments in terms of psychological or factorial meanings and predictive uses. 4 cr.

## 823. GROUP COUNSELING

An analysis of group dynamics as they apply in group situations relevant to personnel services. Prerequisite: Education 820. 4 cr.

## 824. COUNSELING AND GUIDANCE IN THE ELEMENTARY SCHOOL

Principles and procedures of counseling and personnel services for meeting the developmental needs of elementary school pupils. 4 cr.

## 825. LABORATORY IN COUNSELING

An introductory field experience in counseling with supervision and seminar to integrate theory and practice. Prerequisite: Education 820. 4 cr.

## 826. PRACTICUM IN COUNSELING

Supervised experiences in counseling with actual clients in the usual organizational settings. Open only to M.Ed. candidates in counselor education. Prerequisite: permission of instructor. 4 cr.

## 827. ORGANIZATION AND ADMINISTRATION OF PERSONNEL SERVICES

An investigation of the organizational patterns and administrative procedures which influence the effectiveness of personnel services programs. Emphasis is on the elements of productive supervisory and staff relationships. Prerequisite: permission of instructor. 4 cr.

## 828. ADVANCED COUNSELING THEORY AND PRACTICE

A detailed analysis of the counseling relationship: its characteristics, processes, and outcomes. Prerequisite: permission of instructor. 4 cr.

## Education

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### **829. ADVANCED PRACTICUM IN COUNSELING**

Supervised application of advanced counseling theory and practice in actual counseling situations. Samplings of counseling practices will be analyzed and evaluated. Open only to CAGS candidates in counselor education. Prerequisite: Education 828 and permission of instructor. 4 cr.

### **830. RESEARCH IN PERSONNEL SERVICES**

A study of research design and methodology in personnel services. Prerequisite: permission of instructor. 4 cr.

### **831. SEMINAR AND PRACTICUM IN ELEMENTARY SCHOOL TEACHING**

Supervised Practicum: An exploratory summer practicum in a local summer elementary school designed to examine teaching as a career and to prepare for the internship in the fall. The summer includes: 1) a pre-practicum workshop focusing on interpersonal skill development; 2) a pre-practicum curriculum and instructional laboratory; 3) a six-week practicum in which candidates, with the help of the staff, serve as the teaching staff in a local summer school; 4) seminars in curriculum and instruction. Opportunities for teaching high school students are available for candidates who wish to determine better what level of teaching they prefer. (Summer Session only.) Prerequisite: admission to the Master of Arts in Teaching Program or Master of Education Program for Preservice Teachers. 8 cr.

### **835. SEMINAR AND PRACTICUM IN SECONDARY SCHOOL TEACHING**

Supervised Practicum: An exploratory summer practicum in a local summer high school designed to examine teaching as a career and to prepare for the internship in the fall. The summer includes: 1) a pre-practicum workshop focusing on interpersonal skill development; 2) a pre-practicum curriculum and instruction laboratory; 3) a six-week practicum in which candidates, with the help of the staff, serve as the teaching staff in a local summer school; 4) seminars in curriculum and instruction. Opportunities for teaching on elementary level are available for candidates who wish to determine better what level of teaching they prefer. (Summer Session only.) Prerequisite: admission to the Master of Arts in Teaching Program or Master of Education Program for Preservice Teachers. 8 cr.

### **838. SOCIOLOGY OF EDUCATION: SOCIAL ORGANIZATION OF SCHOOLS AND COMMUNITY**

Schools are viewed in their socio-cultural context. Work is centered on a number of field studies of urban and suburban communities. Among the topics discussed are the following: (a)

comparative institutional analysis—what is church-like; hospital-like, factory-like, and prison-like about the school; (b) relations and perspectives of functionaries and clients in “culturally deprived” and “culturally endowed” settings; and (c) teaching as an emergent profession. 4 cr.

### **841. CHILD DEVELOPMENT FOR THE EARLY CHILDHOOD PROFESSIONAL**

As a means of understanding child growth components the course will involve students in extended contacts with significant adults related to children in an early learning environment. Such involvement includes home visits to interview parents, relatives, and to observe the child in the family setting. These primary experiences will be extended through readings, discussions, case study models, film viewings, and continued in-depth child study. Prerequisite: previous experience with young children. 4 cr.

### **843. ENVIRONMENT FOR EARLY CHILDHOOD**

An examination of a variety of Early Childhood environments with attention to use of time, space, and materials. The course is designed to assist Early Childhood professionals to examine their multiple roles in providing appropriate Learning Center adjustments in order to maximize the personal development of different children. Prerequisite: previous experience with young children. 4 cr.

### **846. ASSESSMENT IN EARLY CHILDHOOD**

This course will necessitate that students be familiar with, administer, as well as design, a range of assessment materials for young children. Within the context of Early Learning Centers students will employ various strategies for the selection and utilization of clusters of assessment materials. An essential phase of the course involves the collection and organization of data concerning the children assessed. Prerequisite: Education 841 and 843. 4 cr.

### **848. CONTEMPORARY INFLUENCES UPON EARLY CHILDHOOD EDUCATION**

A survey of contemporary influences upon Early Childhood Education involving an examination of a variety of early childhood models in this country and abroad largely through field experiences (United States, Canada, and England). The course is designed with a view to the student's individual application to the specific early learning situation. Prerequisite: current involvement with a specific group of children. 4 cr.

## 850. FOUNDATIONS OF EARLY CHILDHOOD EDUCATION

An examination of the historical roots that underlie many contemporary practices in Early Childhood Education. The course seeks to provide the professional with a perspective of historical precedents in content, methodology, and change along with extended study and review in child development, assessment, classroom environments, and contemporary practices in order to function more effectively in current work with young children. Prerequisite: Education 841, 843, 846, and 848. 4 cr.

## 853. SEMINAR IN CURRICULUM STUDY

The techniques and procedures of curriculum development and strategies for curriculum change in the public school. Prerequisite: teaching experience. 4 cr.

## 858. ANALYSIS OF TEACHING

A comparative analysis of current techniques and instrumentation for studying the process of teaching in the classroom. Consideration of substantive and procedural issues involved in planning for teaching. Prerequisite: teaching experience. 4 cr.

## 861. PUBLIC SCHOOL ADMINISTRATION

An introductory course examining major issues in policy-making, school management, personnel, public relations, finance, and research in school administration. Prerequisite: teaching experience. 4 cr.

## 862. EDUCATIONAL FINANCE AND BUSINESS MANAGEMENT

Principles of financing education, budgetary procedures, accounting, auditing, school indebtedness, financial reporting and business management. Experience in handling practical school finance problems will be part of the project work. Prerequisite: Education 861. 4 cr.

## 863. SEMINAR IN EDUCATIONAL ADMINISTRATION

Cases and concepts in educational administration. Prerequisite: Education 861. 4 cr.

## 864. PERSONNEL AND COMMUNICATION IN EDUCATIONAL ORGANIZATIONS

Problems arising from the communications process will be examined and attention given to implications of group problem-solving processes. Interpersonal relations and group dynamics among students, faculty, staff, administration, and the community will be given attention. Classes will meet once weekly. Emphasis will be upon application of theories. 4 cr.

## 865. EDUCATIONAL SUPERVISION

Theoretical foundations of supervisory behavior as a means of effecting changes in instructional practices; consideration of instruments and techniques based on those theoretical foundations; some opportunity for field projects utilizing instruments and techniques. Prerequisite: teaching experience. 4 cr.

## 866. PRACTICUM IN SUPERVISION AND CURRICULUM

Students will engage in activities requiring supervision of teaching and curriculum development projects in the schools. The practicum will provide the opportunity to apply skills in supervising and curriculum development techniques. Prerequisites: Education 853, Education 865, and permission of the instructor. 4 cr.

## 867. LEGAL ASPECTS OF SCHOOL ADMINISTRATION

For persons interested in public school administration. In-depth investigation of the increasingly complex relationship of law to public education. Emphasis on aspects of the federal constitution, New Hampshire statutes, and case law related to the important public interests being served by elementary and secondary education. Special topics: church-state relationship, due process, desegregation, state agencies, supervisory unions, school districts, school boards, teacher employment, negotiations, student rights, tort liability, school finance. Prerequisite: Education 861 and 863. 4 cr.

## 869. PRACTICUM IN EDUCATIONAL ADMINISTRATION

Supervised practical experience in dealing with problems in educational administration. Prerequisite: Education 863. 4 cr.

## 870. THE CHANGE PROCESS IN EDUCATION

The role of change agent and the change process in education as related to school personnel will be stressed. Structural characteristics of the school culture will be examined. Change theory and systems analysis techniques will be presented. Students will be required to apply some of the theories in an institutional setting. 4 cr.

## 874-875. ADMINISTRATIVE INTERNSHIP AND FIELD PROJECT

A field-based internship providing a variety of administrative experiences in one or several educational and community agencies. Interns will participate directly in the administrative and supervisory work of the agencies. Additionally, each intern will complete a major field project requiring analysis and action appropriate for the resolution of a significant administrative problem at the intern-site. Supervision by University faculty members will be provided. Permission of graduate adviser is required. 6 cr.

# Electrical Engineering

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## 881. METHODS AND TECHNIQUES OF EDUCATIONAL RESEARCH

Quantitative methods employed in the investigation of educational problems. Permission of instructor. 4 cr.

## 883. ADVANCED PSYCHOLOGY OF HUMAN LEARNING

Special topics in the field of educational psychology with emphasis on the learning process: (a) examination of learning situations in the classroom in the light of experimental research; (b) examination and evaluation of learning situations in the light of the major theories of learning. Prerequisite: Education 657, Psychology of Human Learning. 4 cr.

## 884. ADVANCED HUMAN DEVELOPMENT

A personal exploration of the social, psychological, and educational aspects of human development. Special emphasis on emotional growth through school practices in human encounter. Prerequisite: permission of instructor. 4 cr.

## 886. PHILOSOPHY OF EDUCATION

A seminar in comparative analysis of contemporary educational objectives and practices and the philosophical foundations upon which they are based. Application of theoretical criteria for assessing educational philosophies and for developing one's own position. 4 cr.

## 888. SOCIOLOGY OF EDUCATION: THE CULTURES OF POVERTY AND AFFLUENCE

The two cultures are treated as a unit; culture change is discussed. Issues of current interest are explored, e.g., poverty, school desegregation, the schooling of geographically mobile children, problems of social mobility and abundance, the rise of the counseling and healing trades, and teachers' quest for professionalism. The education of "culturally deprived" and "culturally endowed" children receives special attention. A comparative approach is adopted; issues are examined cross-culturally and in relation to the schooling process. 4 cr.

## 889. SOCIOLOGY OF EDUCATION: RACE AND ETHNIC RELATIONS IN SCHOOL AND SOCIETY

This course deals with ethnic stratification and inter-group processes both inside and outside the school. The public schooling of disadvantaged groups such as black, Indian, white Appalachian, and Mexican Americans receives special attention. Caste and class relations between schoolmen, parents, and pupils are examined within social contexts as slums, reservations, Levittowns, and "golden ghettos." A socio-anthropological perspective is emphasized. 4 cr.

## 895. INDEPENDENT STUDY IN EDUCATION

An opportunity for intensive investigation of a special problem or issue in the field of education. Permission of instructor is required. 2-4 credits per semester. May be repeated to a maximum of 8 cr.

## 899. THESIS

Prerequisite: permission of the department. 8 cr.

# Electrical Engineering (50)

**Chairman:** Joseph B. Murdoch

**PROFESSORS:** Fletcher A. Blanchard, Albert D. Frost, Joseph B. Murdoch, Alden L. Winn

**ASSOCIATE PROFESSORS:** Ronald R. Clark, Glen C. Gerhard, Filson H. Glanz, Donald W. Melvin, John L. Pokoski, Kerwin C. Stotz, K. Sivaprasad

**ASSISTANT PROFESSOR:** M.R. Cannon

**GRADUATE COORDINATOR:** Kerwin C. Stotz

To be admitted to graduate study in electrical engineering a student should have completed a baccalaureate degree in electrical engineering or comparable training which included courses in mathematics and physical science, network theory, fields and waves, electronics, solid state circuits, semiconductor device theory, and energy conversion, with appropriate laboratory experiences.

A minimum of 30 credits is required for the Master of Science degree in Electrical Engineering. All students are required to complete two basic courses, Electrical Engineering 701 and 811, at the beginning of their program or furnish evidence of equivalent preparation. Students are further required to demonstrate the ability to do independent and creative work by taking either Electrical Engineering 899 or 891-892. With the consent of the Graduate Committee, a student who has satisfied this requirement through industrial experience may substitute approved course work.

Electrical Engineering 899 and 891-892 both involve equivalent independent theoretical and/or applied work under the guidance of a faculty member. The sequence, 891-892, is to be completed in two consecutive semesters, with a letter grade given at the end of each semester. An interim report is submitted at the end of 891 and a final (oral and written) report at the end of 892. Electrical Engineering 899 requirements include the submission of a formal thesis suitable for binding. However, no two-semester time limit is imposed, and no interim or final letter grade is given.

Those who intend to undertake graduate work in Electrical Engineering must consult with the department graduate adviser in order to plan the program of study, since all courses are not given each

year. Normally, a minimum of 12 credits of 800-level courses is required, not including 891-892 or 899.

An interdepartmental Engineering Ph.D. Program is also available in the following areas of specialization: engineering system design, signal processing, theoretical and applied mechanics, and transport phenomena. Electrical engineering students would normally work in one of the first two above areas. For details refer to the section entitled Engineering Ph.D. Program on page 70.

Permission of instructor is required for enrollment in all electrical engineering graduate courses.

## Areas of Specialization

Courses may be selected to provide a specialization in the following program areas, both for the M.S. degree or for the Ph.D. program.

### Bioelectronic and Medical Systems

Topics of study in this area include biotelemetry of physiological data from humans, animals, and plants, and applications of signal processing and instrumentation techniques to medical areas.

### Communications Systems and Information Theory

Areas of interest and activity include electromagnetic and acoustic wave technologies, and the identification of signals in the presence of noise through the use of coding correlation or optimal filtering. Related facilities for experiments extending from VLF to microwaves are available at a roof-top communications system for space, terrestrial, and ocean applications.

### Computer Engineering and Digital Systems

Theoretical aspects of switching theory; application of switching logic, design and interfacing of minicomputer peripherals; application of minicomputers to process control and bio-electronics. The Digital Systems laboratory includes four minicomputers with magnetic tape units, teletype terminals, high speed paper tape units, AD and DA converters, graphics output, and interconnect capability with a TR-48 analog computer.

### Control and Systems Engineering

Digital, hybrid, and analog computer control of industrial processes and systems. Discontinuous and fluidic control theory for industrial, marine, and oceanographic applications. Linear and stochastic analysis, synthesis techniques in the frequency domain, optimal control, and systems optimization.

### Fields and Waves

Radiation of electromagnetic waves in a plasma, electromagnetic probing of media with pulses, propagation studies in weakly

turbulent media such as sea, the atmosphere, and plasmas. Acoustic reverberation studies in the ocean.

### Network Theory

Active network synthesis techniques, application of network theory to societal systems, sensitivity studies of passive and active network synthesis methods, digital adaptive equalizers, and analysis and design of linear phase and constant delay networks.

### Ocean Engineering and Instrumentation

Instrument systems (digital and analog) for measuring and recording physical, chemical, and biological parameters primarily associated with ocean behavior, e.g., temperature, pressure, and salinity measurements at mid-ocean depths; wave height and direction determination; buoy performance as affected by waves and currents; remote sensing of the ocean surface; diver physiological data monitoring; and underwater acoustics.

### Solid State Electronics; Semiconductor Devices and Materials

Experimental and theoretical considerations of semiconductor devices and materials including device fabrication technology, e.g., laboratory work involving silicon monolithic devices, research in photosensors, especially in the infrared, and in infrared systems with applications to the remote sensing of the environment.

## 620. ELECTRONICS AND INSTRUMENTATION

For non-engineering or non-physics students; no mathematical or engineering detail. Techniques for using electronic instruments and equipment. DC and AC circuits, electronic amplifiers, grounding and shielding problems, transducers, electronic instruments, schematic reading, transients, noise problems, and digital techniques. Prerequisite: junior standing. 3 rec/1 lab/4 cr.

### (701). APPLIED ELECTROMAGNETIC FIELDS

Maxwell's equations; boundary value problems in electrostatics and magnetostatics; plane wave propagation; reflection and refraction; guided wave propagation; wave guides; simple resonators; elements of microwave circuits, linear and aperture antennas, arrays of dipoles; receiving antennas. Prerequisite: E.E. 603 and 604 or equivalent. 3 rec/1 lab/4 cr.

## 711. DIGITAL SYSTEMS

Extension of E.E. 543 to advanced switching theory techniques (design of unclocked sequential circuits, minimization of multiple output circuits, etc.) and digital design tools (L.S.I., multiplexing, etc.). Applications featured. Prerequisite: E.E. 543 or permission of instructor. 3 rec/1 lab/4 cr.

# Electrical Engineering

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## 712. LOGICAL DESIGN OF DIGITAL COMPUTERS

Computer architectures, including arithmetic, memory, control, and input-output units; the trade-offs between hardware, software, and cost. "Hands on" laboratory experience with machine language programming, interfacing of peripherals, etc., on minicomputers and microcomputers. Prerequisite: E.E. 543 or permission of instructor. 3 rec/1 lab/4 cr.

## 714. MINICOMPUTER APPLICATIONS ENGINEERING

Organization and operation of minicomputer-based systems. Interfacing of special purpose peripherals, data structures, control structures, program and data organization, microprogramming, real-time monitor systems. Applications to communication, automated-measurement, and process control systems. Prerequisite: E.E. 543 and programming experience, or permission of instructor. 3 rec/1 lab/4 cr.

## 727. POWER SYSTEMS

Modeling and planning of electric power transmission systems. Prerequisite: E.E. 654. 4 cr.

## 741. FUNDAMENTALS OF ACOUSTICS

Acoustic wave equation for air; laws of reflection, refraction, and absorption; characteristics and measurement of acoustical sources; microphones; sound level; acoustical materials, ultrasonics; architectural acoustics. Prerequisite: Physics 408, Math 527. 3 rec/1 lab/4 cr.

## 757. FUNDAMENTALS OF COMMUNICATIONS

Communications systems, Fourier analysis of signals, AM and FM detection, digital and sampled-data signals, noise in electrical circuits. Prerequisite: E.E. 608 and permission of instructor. 3 rec/1 lab/4 cr.

## 758. COMMUNICATION SYSTEMS

Design of high frequency communication systems. RF amplification, modulators for AM and FM systems, receiving techniques, antennas, free space propagation, propagation characteristics of the ionosphere. Prerequisite: E.E. 604, 757 or equivalent. 3 rec/1 lab/4 cr.

## 762. ILLUMINATION

Radiation; color and spectra; physics of light production; sources of ultra-violet, visible, and infrared energy; lamp circuitry; control of light; lighting design, applications of light in business, industry, school, home, and outdoors. 4 cr.

## 770. INTEGRATED CIRCUIT DESIGN AND TECHNOLOGY

Operation, design, processing, and technology of linear and nonlinear integrated circuits. Bipolar and unipolar structures, including surface controlled devices. Thin-film hybrid circuit techniques, vacuum technology, opto-electronic devices, and microwave active circuits. Prerequisite: E.E. 552 and 609. 2 rec/2 lab/4 cr.

## 775. APPLICATIONS OF INTEGRATED CIRCUITS

The design and construction of linear and nonlinear electronic circuits using existing integrated circuits. Use of operational amplifiers. Laboratory course in practical applications of non-digital integrated circuit devices. 4 cr.

## 781. OCEAN INSTRUMENTATION PROJECT

Interdisciplinary solution of a real-world problem; measurements of physical, chemical, or biological parameters in an ocean or fresh-water environment. Student team formulates system specification, assembles components, and designs a test procedure for demonstrating the feasibility of the prototype system. Written final report and oral demonstration before a panel of invited experts. Prerequisite: senior standing in Engineering. 4 cr.

## 782. CONTROL SYSTEMS

Design and analysis of feedback control system. Stability criterion, time- and frequency-domain analysis, introduction to nonlinear systems. Prerequisite: permission of instructor. 3 rec/1 lab/4 cr.

## 784. BIOELECTRONICS

Survey of engineering principles applied to medicine including physiological measurements, biotelemetry, modeling and simulation, electrical safety, biosignal processing, and computer applications. Prerequisite: permission of instructor. 3 rec/1 lab/4 cr.

## (785). UNDERWATER ACOUSTICS

Vibrations, propagation, reflection, scattering, reverberation, attenuation, sonar equations, ray and mode theory, radiation of sound, transducers, and small and large signal considerations. Prerequisite: permission of instructor. 4 cr.

## 786. INTRODUCTION TO RADIO ASTRONOMY

Electromagnetic radiation, propagation. Positional astronomy and the radio sky, discrete radio sources, source structure distribution, the sun as a radio source, flare and burst activity,

planetary emissions, quasars, pulsars, techniques of observation and data reduction, radiometry, polarimeters, correlation interferometers, aperture synthesis. Prerequisite: senior or graduate status in technology. 4 cr.

## **796 (796). SPECIAL TOPICS IN ELECTRICAL ENGINEERING**

New or specialized courses and/or independent study. Prerequisite: permission of instructor. 2 or 4 cr.

### **801. ELECTROMAGNETIC FIELD THEORY**

Review of Maxwell's equations. Green's function method for solution of electrostatic problems. Wave propagation in isotropic, anisotropic, and ionized media; propagation over a plane; surface waves. Prerequisite: Electrical Engineering 701. 3 cr.

### **802. ELECTROMAGNETIC WAVE THEORY**

Selected advanced topics in electromagnetic wave theory taken from such areas as: antennas; propagation in various media; diffraction and scattering; microwave generation and waveguide propagation. Prerequisite: EE 801. 3 cr.

### **811. FUNDAMENTALS OF SIGNAL PROCESSING**

Matrices and determinants, introductory graph theory. Laplace transforms, and pole-zero concepts, complex variable theory, convolution, concept of state, formulation and solution of state equations. 3 cr.

### **812. FILTER DESIGN AND SYNTHESIS**

Approximation theory; driving point and transfer synthesis techniques; passive, active, and digital filters. Prerequisite: Electrical Engineering 811. 3 cr.

### **815. ADVANCED ACTIVE CIRCUITS**

Investigation of devices and techniques used in advanced circuit design using discrete solid-state devices and integrated circuits. Topics will include oscillators, phase-locked systems, low noise techniques, etc. 3 cr.

### **817. SPECIAL TOPICS IN NETWORK THEORY**

Study of advanced topics in network theory of interest to students and staff, taken from such areas as nonlinear networks, distributed networks, time domain synthesis, computer aided design, time varying networks, n ports, linear graph theory. Prerequisite: EE 812. 3 cr.

### **831. SOLID STATE ELECTRONICS I**

A study of topics in solid state electronics including semiconductor physics, crystal structure, band theory, transport phenomenon, recombination, and PN junctions. Semiconductor fabrication process theory will be introduced. Prerequisite: Electrical Engineering 505, Electronic Properties of Materials and Devices, or equivalent. 3 cr.

### **832. SOLID STATE ELECTRONICS II**

A continuation of Electrical Engineering 831, emphasizing the theory of semi-conductor devices including bipolar, field-effect, and surface-controlled transistors, monolithic and hybrid integrated circuits, photoconductors, injection luminescent diodes, semiconductor laser and bulk effect devices, as well as selected applications and topics in theory of semiconductor technology. Prerequisite: Electrical Engineering 831. 3 cr.

### **839. STATISTICAL THEORY OF COMMUNICATIONS**

An introduction to probability theory and random waveforms leading to a discussion of optimum receiver principles. Topics include random variables, random processes, correlation, power spectral density, sampling theory, and optimum decision rules. Prerequisite: Electrical Engineering 811. 3 cr.

### **840. INFORMATION THEORY**

A continuation of Electrical Engineering 839. Introduction of information-theory concepts. Topics include: message sources, entropy, channel capacity, fundamentals of encoding, Shannon's theorems. Prerequisite: Electrical Engineering 839. 3 cr.

### **841. DIGITAL SIGNAL PROCESSING**

An introduction to the theory and practice of digital signal processing. Topics covered include the elements of nonrecursive and recursive digital filters, random number generators and simulation of time series, the Fast Fourier Transform, spectral estimation, envelopes and phases, modeling of time series. Samples of data from various physical experiments will be analyzed as student projects. Some exposure to programming is desirable. 3 cr.

### **851. ADVANCED CONTROL SYSTEMS I**

State-space representation of systems. Analysis using state transition matrix. Controllability and observability. Synthesis of optimum control systems, including calculus of variations and maximum principle. Introduction to nonlinear and stochastic control-systems including stability concepts using Liapunov and Popov criteria. Sampled-data systems. Prerequisite: Electrical Engineering 782. 3 cr.

## Engineering Ph.D. Program

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### 852. ADVANCED CONTROL SYSTEMS II

Special topics in control theory such as multivariate and adaptive control system; stochastic systems; Wiener and Kalman filter techniques; introduction to dynamic, linear and nonlinear programming. Prerequisite: Electrical Engineering 851. 3 cr.

### 856. SWITCHING THEORY

Combinational circuits—including functional decomposition, non-binary logic, and cellular networks. Sequential networks—including analysis, transient behavior, state reduction methods, state assignment, and synthesis. Prerequisite: Electrical Engineering 711. 3 cr.

### 891-892. RESEARCH

3 cr. each semester.

### 898. INDEPENDENT STUDY

Independent theoretical and/or experimental investigation of an electrical engineering problem under the guidance of a faculty member. 1-3 cr. per semester.

### 899. MASTER'S THESIS

6 cr.

## Engineering Ph.D. Program (54)

**PROFESSORS:** Victor D. Azzi, Fletcher A. Blanchard, Robert W. Corell, Stephen L. Fink, Albert D. Frost, Shan S. Kuo, Joseph B. Murdoch, Godfrey H. Savage, Charles K. Taft, Robin D. Willits, Alden L. Winn, Asim Yildiz

**ASSOCIATE PROFESSORS:** Ronald R. Clark, Stephen S.T. Fan, Glen C. Gerhard, Filson H. Glanz, R. Stephen Jenks, Louis H. Klotz, Harold E. Langley, David E. Lambert, Donald W. Melvin, William Mosberg, John L. Pokoski, Kondagunta Sivoprasad, Linda A. Sprague, Kerwin C. Stotz, Russell L. Valentine, Tung-Ming Wang, John A. Wilson

**ASSISTANT PROFESSORS:** Paul L. Bishop, Michael Cannon, Barbaros Celikkol, Dennis J. O'Brien, Gail D. Ulrich

**ENGINEERING Ph.D. COMMITTEE:** Asim Yildiz, Ronald R. Clark, Stephen S.T. Fan, Robert W. Corell

An interdepartmental engineering program offers graduate work leading to the degree of Doctor of Philosophy and is conducted by a combined engineering faculty. The program consists of areas of specialization within an interdepartmental structure, depending principally upon strengths in engineering, the engineering sciences, mathematics, and the physical sciences. An interdepartmental program is

felt to be most meaningful since many contemporary engineering and scientific problems can be solved only through the cooperation of a variety of disciplines. Further, the boundaries between the classical disciplines in engineering and science have become increasingly indistinct. The particular advantage of the nondepartmental program structure is that improved communication and cooperation develop among faculty and students of the different disciplines and results in more meaningful academic and professional experiences.

### Areas of Specialization

The Engineering Ph.D. program includes the following four areas of specialization:

#### Engineering System Design: Robert W. Corell, Chairman

Students entering this area of the Engineering Ph.D. program can elect either one of two professional directions. The first seeks to develop professionals and with the technical expertise of a Ph.D. and with the ability to work with and direct groups of people working on large-scale projects. The second seeks to develop engineers with capabilities in the theory and analysis of large-scale complex systems. Concentration in an area of specific individual interest is combined with participation in a larger interdisciplinary project.

Current projects related to the area include coastal engineering, marine soil mechanics, submersibles and underwater habitats, ocean instrumentation, marine structures and buoy systems, arctic engineering, discontinuous control systems, fluidic systems, nonlinear decoupling control, societal systems, facility systems, and social and business systems.

#### Signal Processing: Ronald R. Clark, Chairman

This area of specialization is concerned with those analytic and experimental techniques that are involved in some aspect of the acquisition, detection, identification, or control of signals. In this context a signal is defined as any quantity which contains or conveys information. While the majority of signal processing systems are partially or wholly electrical in nature, many of the basic aspects of signal processing and utilization are common to a wide range of problems and applications in communications, medicine, environmental modeling, instrumentation, and control.

Current research topics include: network synthesis, bioelectronic telemetry, radio astronomy, ionospheric irregularities, pattern recognition, semi-conductor device fabrication, coherent signal analysis, surface-wave antennas, digital control, nonlinear interacting system-control, and fluidics.

#### Theoretical and Applied Mechanics: Asim Yildiz, Chairman

Treated as an engineering science, this area brings together those aspects of engineering, physics, and applied mathematics that



are relevant to the understanding and application of the dynamical and equilibrium behavior of materials and structures. Included are the fields of solid mechanics, structural mechanics, classical and continuum mechanics, rheology, theoretical soil mechanics, biomechanics, elastodynamics, and acoustics.

Current research topics include macro- and micro-mechanics of composite-material behavior, wood-fiber mechanics, viscoelastic material properties, structural dynamics, structural optimization, elastodynamics, elastic wave propagation, scattering of elastic waves, electromagnetic wave propagation, theoretical soil mechanics, ocean-cable dynamics, ocean engineering, ocean subbottom resources, oceanography, acoustic determination of the properties of layered media, Cosserat fields, and dislocation theories.

### **Transport Phenomena:** Stephen S.T. Fan, Chairman

This area deals with the subjects of fluid mechanics; conductive, convective, and radiative heat transfer; and diffusive mass transfer in a generalized and coordinated approach. In addition to their fundamental role in traditional engineering activities, transport-phenomena studies are expected to make significant engineering contributions in the areas of energy production and utilization, environmental control, oceanography, space exploration, and biomedical engineering.

Current research activities include solar energy, new energy sources, pollution control, biomedical engineering, combustion, adsorption, simultaneous heat and mass transfer, heat transfer with phase change, liquid pumping cavitation, polymer processing, vortex flow, and flow through porous media.

## **Requirements**

Qualified students with bachelor's or master's degrees in engineering, mathematics, or the physical sciences are eligible for admission to the program. To be admitted a student must present evidence that he has sufficient background in the area in which he proposes to specialize.

Following the entrance of a student into the program, a Guidance Committee will be appointed for the student by the dean of the Graduate School upon recommendation of the chairman of the student's area. This committee will assist the student in outlining the program and in preparation for the qualifying examination and may require him/her to take specified course work, with or without credit. The committee will also conduct an annual in-depth review of the student's progress, through written and/or oral examinations, and following the substantial completion of the student's course work, will administer the qualifying examination. This committee is also responsible for administering the language examination and other proficiency requirements that are required of the area of specialization.

Upon the successful completion of the qualifying examination and other proficiency requirements, a Doctoral Committee will be appointed by the dean of the Graduate School upon the recommendation of the chairman of the student's area. The Doctoral Committee shall conduct an annual review of the student's progress, supervise and approve the doctoral dissertation, and administer the final examination.

To obtain a Ph.D. degree in Engineering a student must meet all of the general requirements as stated under Regulations of the Graduate School. A student will normally be required to demonstrate the ability to read scientific and technical literature in one approved foreign language; however, in specific cases a student's Guidance Committee may require a second language or, in lieu of a language, a demonstrated facility in one or more special research techniques such as digital or analog computation. The student, depending on his educational objectives, may also be required by the Guidance Committee to undertake a classroom teaching experience. To complete the Ph.D. degree in Engineering a student will normally be expected to take course work equivalent to two full-time academic years beyond the baccalaureate and to complete a dissertation which will require at least one full-time year of study and original research. Specific course requirements have been established for each area of specialization. All these requirements should normally be completed by the end of the second year of full-time graduate study, and must be completed before the student can be advanced to candidacy.

### **Course Requirements**

Course work requirements will be developed on an individual basis by each student's Guidance Committee. Since each area of specialization has its own specific course requirements, an interested student should contact the area chairman to determine the particular course work and research activity that may be applicable to his/her educational goals.

Except for Doctoral Research (999), students will follow a program of study consisting of courses from within the chemical, civil, electrical, and mechanical engineering departments, many of which have been established particularly for this program, and from related departments appropriate to the student's needs. A student should consult the Course Descriptions section of this catalog for specific course offerings and descriptions.

### **999. DOCTORAL RESEARCH**

# English

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## English (62)

**Chairman:** Robert Hapgood

**PROFESSORS:** Robert Hapgood, Edmund G. Miller, Donald M. Murray, Philip L. Nicoloff, John C. Richardson, Thomas A. Williams  
**ASSOCIATE PROFESSORS:** Thomas A. Carnicelli, Michael DePorte, Karl Diller, Carl Dawson, Lewis C. Goffe, Gary H. Lindberg, Terence P. Logan, Mark R. Smith, Theodore Weesner, John A. Yount  
**ASSISTANT PROFESSORS:** Earl Briden, S. Anthony Caldwell, Elizabeth H. Hageman, Annette Kolodny, Andrew H. Merton, Hugh M. Potter III, Alan H. Rose, Susan M. Schibanoff, David V. Siddall, Charles Simic

The Department of English offers three advanced degrees, Master of Arts, Master of Science for Teachers, and Doctor of Philosophy. All applicants are required to submit Graduate Record Examination scores for the Aptitude Test and the Advanced Test of Literature in English. Applicants for the Ph.D. are normally expected to have a reading knowledge of at least one foreign language.

### Master of Arts

The Master of Arts may be undertaken as a terminal degree or as preparation for a doctoral program. The program encourages students to pursue their individual interests and to correct deficiencies in their undergraduate training.

**Courses:** An M.A. candidate must pass eight four-credit courses. Six courses, including at least two seminars and either English 895 or 896, must be at the 800 level. At least four courses must be in English or American literature (as distinct from courses in critical analysis, linguistics, writing, teaching methods, or other literatures). Each M.A. candidate must pass at least one course in the English language or in the teaching of composition. As a general rule, all courses counting toward the M.A. degree should be taken in the English department. In special circumstances, however, a student may be allowed to apply toward the degree up to two graduate courses offered by other departments.

**Language:** An M.A. candidate must pass a reading examination in one of the following languages: French, German, Greek, Italian, Latin, Russian, Spanish.

**Paper:** Each candidate for the M.A. degree must register for four credits of English 895 or 896 and produce a substantial scholarly paper. (The above requirements do not necessarily apply to the specialized options listed below.)

### Specialized Option with an Emphasis on Junior College Teaching

This is a special M.A. program designed for students committed to junior-college teaching. Regular graduate courses, specially designed seminars, and teaching internships in local two-year colleges are features of the program. Further details are available from the secretary for graduate programs, Department of English.

### Specialized Option in Writing

The Master of Arts in Writing is designed for students who intend to become professional writers. Seven working writers supervise the program. Students may elect to specialize in fiction, non-fiction, or poetry. Each member of the writing faculty is accomplished in at least one of these fields.

The writers at UNH emphasize conference teaching. Each student meets frequently with writers specializing in the student's area of study. In addition, each student works closely with a writer-adviser throughout the program.

Workshop courses provide forums for prompt, detailed criticism of each student's writing by instructors and fellow students. Each student takes at least two workshops in his or her specialty, and may elect to take an additional workshop in another area as well. Form-and-theory courses and literature courses complete the program.

Upon completion of the required courses the student submits a portfolio of writing to the staff. The portfolio might consist of short stories, a novel, non-fiction articles, a non-fiction book, or a collection of poetry. The degree is awarded upon approval of the portfolio by a committee of writers.

### Specialized Option in English Language and Linguistics

Students who wish to specialize in any of the various areas of English Language and Linguistics may design an M.A. program to meet their interests. The graduate committee of the department must approve all such program designs. Specialties include applied linguistics and the teaching of English as a second language as well as the traditional sub-fields of linguistics. Psycholinguistics is offered through the psychology department. Seven four-credit courses, including two seminars, must be completed, plus an independent study course leading to a scholarly paper. Reading knowledge of one foreign language is required.

## Master of Science for Teachers

The Master of Science for Teachers is designed for the high school teacher. No foreign language is required. The student must take eight courses in English, numbered above 700, which will not be a repetition of undergraduate work. Applicants should consult the General Regulations of the Graduate School for the special admissions requirements for this program.

## Doctor of Philosophy

To be admitted to the Ph.D. program the student must hold an M.A. degree or be in the final stage of completing requirements for the degree.

The Ph.D. program offers professional training in the study and teaching of literature and language. The program combines the essential guidance and discipline of course work with the equally essential freedom of independent study and research. Accordingly, in the first year of study primary stress is upon courses, while in the second year the student is encouraged to follow a program suited to individual interests and needs. In addition to meeting course requirements, each student must pass: 1) reading examinations in two foreign languages (French, German, Greek, Italian, Latin, Russian, Spanish), 2) near the beginning of the work for the Ph.D. degree, a ninety-minute oral General Examination, and 3) a later written and oral Qualifying Examination in three areas related to his proposed dissertation: an historical period, a genre or a related field, and a major author. A student must also write a dissertation and defend it at a final oral examination. The program is designed to be completed within three years of full-time study after the M.A.

Graduate students should note that not all seminars are offered every year.

M.A. and Ph.D. students holding assistantships teach under supervision; such teaching is considered a vital part of the student's professional training.

A detailed guide to the department's graduate program is available from the secretary for graduate programs, Department of English.

### 701-702/801-802. ADVANCED WRITING OF FICTION

Prerequisite: Engl. 625-626 or its equivalent and permission of instructor. May be repeated for credit with the approval of the department chairman. 4 cr.

### 703-704/803-804. ADVANCED NON-FICTION WRITING

Prerequisite: permission of instructor. May be repeated for credit with the approval of the department chairman. 4 cr.

### 705-706/805-806. ADVANCED WRITING OF POETRY

Prerequisite: Engl. 627-628 or its equivalent and permission of instructor. May be repeated for credit with the approval of the department chairman. 4 cr.

### 707. FORM AND THEORY OF FICTION

The problems, aims, and structures of fiction from the point of view of the writer. 4 cr.

### 708. FORM AND THEORY OF NON-FICTION

Contemporary non-fiction from the point of view of the writer, emphasizing the choices the writer faced in the process of research and writing. 4 cr.

### 709. FORM AND THEORY OF POETRY

From the writer's point of view. Readings in major literary figures who have shaped American poetry in the twentieth century. 4 cr.

### 710. CRITICAL ANALYSIS OF FICTION

A non-historical approach to individual short stories and novels. 4 cr.

### 711. CRITICAL ANALYSIS OF POETRY AND DRAMA

A non-historical approach to individual poems and plays. 4 cr.

### 712. CRITICAL ANALYSIS OF EXPOSITION

For the English Teaching major; students analyze essays and write non-fiction prose. Variety of critical approaches; several methods of teaching composition. 4 cr.

### 713, 714/813, 814. LITERARY CRITICISM

Major critics from Plato to the present and the chief critical approaches to literature. 4 cr.

### 715/815. APPLIED LINGUISTICS

Methods of teaching and learning foreign languages; background work on theories of language acquisition; the methodology of teaching English as a second language. Students interested in teaching other languages may do their projects on those languages. 4 cr.

### 716/816. PROBLEMS IN APPLIED LINGUISTICS

Variable topics course; problems such as language acquisition in children and adults, bilingualism, and linguistic field methods. 4 cr.

# English

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## 718/818. ENGLISH LINGUISTICS

Introduction to linguistics; transformational, generative grammar. 4 cr.

## 719. ENGLISH GRAMMAR

Traditional and contemporary approaches to the structure of English; morphology and syntax, parts of speech, phrases, clauses, sentences, punctuation, etymology. 4 cr.

## 720. NEWSPAPER INTERNSHIP

Students intending to pursue careers in journalism spend a semester working full-time for a daily newspaper under close supervision of editors. Reporting is stressed, but the student may do some editing as well. The number of internships is very limited. Prerequisite: Engl. 621 or its equivalent and permission of instructor. Variable, max. 16 cr.

## 742/842. PURITANISM AND THE ENLIGHTENMENT IN AMERICA

American literature and thought from the Colonial beginnings through the early republic. 4 cr.

## 743/843. AMERICAN TRANSCENDENTALISTS

Emerson, Thoreau, and other transcendentalists. 4 cr.

## 744/844. AMERICAN FICTION TO THE CIVIL WAR

Cooper, Poe, Hawthorne, Melville, and others. 4 cr.

## 745/845. AMERICAN POETRY OF THE 19th CENTURY

Bryant, Poe, Emerson, Whitman, Dickinson, and others. 4 cr.

## 746/846. AMERICAN REALISM AND NATURALISM

Twain, Henry James, Howells, Stephen Crane, Dreiser, and others. 4 cr.

## 747, 748/847, 848. AMERICAN FICTION AND DRAMA OF THE 20th CENTURY

Major writers since World War II. Selections vary from year to year. 4 cr.

## 749/849. AMERICAN POETRY OF THE 20th CENTURY

Robinson, Frost, Stevens, Pound, Eliot, Jeffers, Hart Crane, Robert Lowell, and others. 4 cr.

## 752/852. HISTORY OF THE ENGLISH LANGUAGE

The evolution of the English language and relation between linguistic change and literary style. 4 cr.

## 753/853. OLD ENGLISH

Introduction to Old English language and literature through readings of selected poetry and prose. 4 cr.

## 754/854. BEOWULF

A reading of the poem and an introduction to the scholarship. Prerequisite: Engl. 753. 4 cr.

## 755, 756/855, 856. CHAUCER

755: Chaucer's allegorical poems and *Troilus and Criseyde*. 756: *The Canterbury Tales*. 4 cr.

## 757-758/857-858. SHAKESPEARE

757: Surveys of a number of representative plays. 758: Studies a few plays more intensively. 4 cr.

## 759/859. MILTON

Milton's life and times, all his poetry, and a selection of his prose. 4 cr.

## 763, 764/863, 864. ENGLISH LITERATURE IN THE 16th CENTURY

763: Major literary figures of the continental Renaissance (in translation), including Petrarch, Machiavelli, Rabelais, Montaigne, Cervantes, and Erasmus; major English writers, including More and Skelton. 764: Sidney, Spenser, and other non-dramatic writers of the Elizabethan period. 4 cr.

## 765, 766/865, 866. ENGLISH LITERATURE IN THE 17th CENTURY

765: Major poets and prose writers of the early 17th century: Donne, Herbert, Jonson, Marvell, Bacon, Burton, Browne. 766: Hobbes, Locke, Dryden, Rochester, Bunyan, and selected Restoration plays. 4 cr.

## 767, 768/867, 868. ENGLISH LITERATURE IN THE 18th CENTURY

767: Swift, Pope, Addison, Gay, Defoe, Montesquieu. 768: Fielding, Gray, Johnson, Boswell, Gibbon, Goldsmith, Sterne, Blake, Voltaire, Rousseau. 4 cr.

## 769, 770/869, 870. THE ENGLISH ROMANTIC PERIOD

769: Wordsworth, Coleridge, Lamb, Hazlitt, DeQuincey. 770: Byron, Shelley, Keats. 4 cr.

## 771, 772/871, 872. VICTORIAN PROSE AND POETRY

771: Carlyle, Mill, Ruskin, Newman, Tennyson, and Browning. 772: Arnold, Clough, the pre-Raphaelites, Swinburne, Hopkins, Hardy, Housman, and others. 4 cr.

## **773, 774/873, 874. BRITISH LITERATURE OF THE 20th CENTURY**

Conrad, Joyce, Yeats, Eliot, Woolf, Lawrence, Auden, and others. 4 cr.

## **781, 782/881, 882. INTRODUCTION TO ENGLISH DRAMA**

The development of English drama, exclusive of Shakespeare, from the Middle Ages to the present. 781: from the Middle Ages to the closing of theatres in 1642. 782: from the Restoration to the present. 4 cr.

## **783/883. THE ENGLISH NOVEL OF THE 18th CENTURY**

The rise and development of the novel through study of selected major works by Defoe, Richardson, Fielding, Smollett, Sterne, and Austen. 4 cr.

## **784/884. THE ENGLISH NOVEL OF THE 19th CENTURY**

Representative novels from among Austen, Scott, Dickens, Thackeray, Emily Bronte, Charlotte Bronte, Trollope, George Eliot, Hardy, and Conrad. 4 cr.

## **791-792. ENGLISH EDUCATION—PROBLEMS IN THE TEACHING OF HIGH SCHOOL ENGLISH**

Methods and techniques of teaching language and literature in grades 7-12. Required of all students in the English-teaching major. Open to English majors with permission of instructor. *No credit toward the English major.* 2 cr.

## **793/893. PHONETICS AND PHONOLOGY**

Phonetics and phonology in the context of linguistic theory; comparisons of English to other languages. Prerequisite: a basic linguistics course or permission of the instructor. 4 cr.

## **794/894. SYNTAX AND SEMANTIC THEORY**

Relation between grammar and meaning; special reference to poetic language. Prerequisite: Engl. 718 and 752 or permission of the instructor. 4 cr.

## **795, 796. INDEPENDENT STUDY**

Individual guided study in special topics. Open to MST candidates. Open under special circumstances to MA candidates upon petition to the departmental graduate committee. Graduate faculty. 1-4 cr.

## **797, 798/897, 898. SPECIAL STUDIES IN LITERATURE**

1) Old English Literature, 2) Medieval Literature, 3) The Renaissance, 4) The 17th Century, 5) The 18th Century, 6) The English Romantic Period, 7) The Victorian Period, 8) The 20th

Century, 9) The Drama, 10) The Novel, 11) Poetry, 12) Non-Fiction, 13) American Literature, 14) A Literary Problem. The precise topics and methods of each section will vary. Barring duplication of subject, may be repeated for credit. For details, see the course descriptions available in the English department. 4 cr.

## **817. SEMINAR IN TEACHING WRITING**

Students are introduced to the writing process, and experience the process themselves by writing and exploring methods of teaching writing. One three-hour meeting plus individual conferences each week. Permission of instructor required. 4 cr.

## **820. SEMINAR IN LINGUISTICS**

4 cr.

## **821. SEMINAR—STUDIES IN OLD ENGLISH**

4 cr.

## **824. SEMINAR—STUDIES IN MEDIEVAL LITERATURE**

4 cr.

## **825. SEMINAR—STUDIES IN SIXTEENTH-CENTURY LITERATURE**

4 cr.

## **827. SEMINAR—STUDIES IN SHAKESPEARE**

4 cr.

## **828. SEMINAR—STUDIES IN MILTON**

4 cr.

## **829. SEMINAR—STUDIES IN EARLY SEVENTEENTH-CENTURY LITERATURE**

4 cr.

## **830. SEMINAR—STUDIES IN EIGHTEENTH-CENTURY LITERATURE**

4 cr.

## **832. SEMINAR—STUDIES IN THE ROMANTIC PERIOD**

4 cr.

## **833. SEMINAR—STUDIES IN THE VICTORIAN PERIOD**

4 cr.

## **834. SEMINAR—STUDIES IN TWENTIETH-CENTURY BRITISH LITERATURE**

4 cr.

# Entomology

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**837. SEMINAR—STUDIES IN AMERICAN LITERATURE OF THE NINETEENTH CENTURY**  
4 cr.

**838. SEMINAR—STUDIES IN TWENTIETH-CENTURY AMERICAN LITERATURE**  
4 cr.

**840. SEMINAR—STUDIES IN ENGLISH DRAMA**  
4 cr.

**895, 896. READING AND RESEARCH**  
Graduate Faculty. 4 or 8 cr.

**899. MASTER'S THESIS**  
6 cr.

**999. DOCTORAL RESEARCH**

## Entomology (20)

**Chairman:** G. Thomas Fisher

**PROFESSOR:** Robert L. Blickle  
**ASSOCIATE PROFESSORS:** G. Thomas Fisher, R. Marcel Reeves  
**ASSISTANT PROFESSOR:** James S. Bowman

For admission to graduate study in entomology an applicant is expected to have at least the basic (Entomology 402) course in entomology as well as adequate preparation in the allied sciences of chemistry, botany, and zoology. Students lacking the necessary background courses may be required to complete certain of these courses which do not carry credit before they are admitted to full candidacy for a degree.

The program of graduate study is designed to meet the needs of those students planning to take further work leading to a career in professional entomology. Areas of specialization include taxonomy, ecology, ethology, biological control, pest management, chemical control, problems in medical entomology, forest entomology, and agricultural entomology. A thesis is required of all candidates for the master's degree. Students are given the opportunity to assist the professional staff in field research and as laboratory assistants, and they are also encouraged to attend professional meetings in their appropriate fields.

No language requirements are made for the M.S. degree.

## 704. MEDICAL ENTOMOLOGY

Especially for students interested in public health or medicine. Insects and arachnids in relation to public health; the biology and control of important disease carriers. Elective for juniors and seniors. Mr. Blickle. 2 lec/1 lab/4 cr.

## 707, 708. ADVANCED ENTOMOLOGY

R1. Taxonomy; R2. Morphology; R3. Aquatic Insects; R4. Insect Physiology. Required of Entomology majors; open to others by permission of instructor. Mr. Blickle, Staff. 2 lec/1 lab/4 cr.

## 709, 710. ADVANCED ECONOMIC ENTOMOLOGY

R1. Agricultural Entomology; R2. Biological Control of Insects; R3. Chemical Control of Insects; R4. Regulatory Entomology; R5. Structural Pest Control. Required of Entomology majors; open to others by permission of instructor. Hours arr. Mr. Fisher, Staff. 2 or 4 cr.

## 801, 802. GRADUATE ENTOMOLOGY

Concentrated studies in insect biology, systematics, and biological control or chemical control of insects. Mr. Blickle, Mr. Reeves, and staff. Subject matter, hours, and credits to be arranged.

## 899 (899). GRADUATE ENTOMOLOGY—MASTER'S THESIS

Mr. Blickle, Mr. Fisher, Mr. Reeves, and staff. Hours and credits to be arranged. 6-10 cr.

## French (63)

**Chairman:** Grover E. Marshall

**PROFESSOR:** Louis J. Hudon  
**ASSOCIATE PROFESSORS:** Edna S. Hudon, Jack R. Vrooman  
**ASSISTANT PROFESSORS:** Rose Antosiewicz, Lydia Crowson, Robert Davis, Grover E. Marshall

The Department of French and Italian offers courses leading to the degree of Master of Science for Teachers in French. To be admitted to graduate study for this degree, the applicant must meet requirements as specified on page 10. The primary intent of the program is to strengthen the linguistic and literary knowledge and skill of secondary-school teachers of French. Students in this program must complete 10 courses. Eight must be in French, six from French courses numbered 800 or above. Two courses may be taken in related departments. For the convenience of in-service teachers, two

courses leading to this degree are offered in the late afternoon hours each semester. Courses are also offered in the Summer Session according to demand. The candidate for this degree must pass a departmental oral and written examination six weeks before the degree is to be granted.

The department is also prepared to offer work leading to the degree of Master of Arts in French. This program is suspended until there is again sufficient interest in it. Those interested in the program are urged to express that interest to the dean of the Graduate School and to the department. The program consists of eight courses and a master's thesis.

All French courses are conducted in French. Except for 899, the courses listed below are also available at the 700 level.

## French

### 791. METHODS OF FOREIGN LANGUAGE TEACHING—FRENCH

Interdepartmental course. Objectives, methods, and techniques in teaching Spanish, French, German, and Latin from elementary through college. Discussion, demonstration, preparation of instructional materials, micro-teaching of the language skills. Prerequisite: permission of instructor. No credit toward a French major. 4 cr.

### (841). FRENCH LITERATURE OF THE MIDDLE AGES

Epic, lyric poetry, and romance. (Offered upon sufficient demand.) 3 cr.

### (842). FRENCH LITERATURE OF THE RENAISSANCE

(Offered upon sufficient demand.) 3 cr.

### 859-860. FRENCH LITERATURE OF THE 17th CENTURY

3 cr. (Alternate years; offered 1975-76.)

### 861-862. 18th CENTURY FRENCH LITERATURE AND THOUGHT

3 cr. (Alternate years; offered 1976-77.)

### 867-868. 19th CENTURY FRENCH LITERATURE

Romanticism and Realism. 3 cr. (Alternate years; offered 1975-76.)

### (870). INTRODUCTION TO MODERN FRENCH POETRY

Baudelaire to the present. 3 cr. (Alternate years; offered 1975-76.)

### 881-882. CONTEMPORARY FRENCH NOVEL AND THEATER

From 1890 to the present. 3 cr. (Alternate years; offered 1976-77.)

### 888. A SEMINAR IN FRENCH LITERATURE

A study of French authors chosen by the instructor. 3 cr. (Alternate years; offered 1976-77.)

### 890. ADVANCED LANGUAGE AND STYLE

Translation of literary texts, intensive study of principal techniques of style, *explication de textes*. 3 cr.

### 895-896. SPECIAL STUDIES IN FRENCH LANGUAGE AND LITERATURE

Individual guided study of the work of a major author, a genre, or specific topics in literature. Training in bibliography and organization of material. Prerequisite: permission of the department chairman. Variable cr.

### 899. MASTER'S THESIS

1-6 cr.

## Italian (64)

### 795, 796. INDEPENDENT STUDY IN ITALIAN LANGUAGE AND LITERATURE

Individual guided study in special topics. Prerequisite: permission of the department chairman. 2 or 4 cr.

## Genetics Program (97)

**Chairman:** Gerald M. Dunn

**PROFESSORS:** James P. Barrett, Walter M. Collins, Gerald M. Dunn, D. MacDonald Green, Harold W. Hocker, Jr., Lincoln C. Pierce, Owen M. Rogers

**ADJUNCT PROFESSOR:** Ernest J. Schreiner

**ASSOCIATE PROFESSORS:** Thomas P. Fairchild, Frank K. Hoornbeek, J. Brent Loy, Willard E. Urban, Jr.

**ASSISTANT PROFESSORS:** W.T. Adams, Yun Tzu Kiang, Robert M. Zsigray

**ADJUNCT ASSISTANT PROFESSOR:** Peter W. Garrett

The interdepartmental Genetics Program offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy.

A qualified student is admitted to the program with the approval of the genetics faculty and the chairman of the department in which he has a major interest. Undergraduate preparation should include mathematics through calculus, chemistry through organic, physics,

## Genetics

animal or plant biology courses and laboratories, and genetics with laboratory. Preparation in statistics and computer science is desirable. All students will be examined shortly after they arrive in order to diagnose their preparation in basic genetics. Students lacking the appropriate preparation may be admitted but will be required to complete certain courses without graduate credit.

The Aptitude section of the Graduate Record Examination is required.

The program is conducted by faculty members from the departments of animal sciences, biochemistry, Institute of Natural and Environmental Resources, microbiology, plant science, and zoology as well as faculty from the Agricultural Experiment Station and the U.S. Forest Service, Northeastern Forest Experiment Station. Areas of specialization in the program are: genetics of plants, animals, microorganisms, and viruses, with emphasis in physiological and quantitative genetics.

The core curriculum in Genetics requires students in the Ph.D. program to take a minimum of one course from each of the following groups of courses: 1) Population Genetics—Introductory course, Genetics 705; 2) Molecular Genetics—Biochemical Genetics, Genetics 770; Microbial Genetics, Microbiology 804; Developmental Genetics, Plant Science 832; 3) Classical Genetics—Plant Genetics, Plant Science 851; Cytogenetics, Plant Science 853; Quantitative Genetics, Animal Science 811; Human Genetics, Zoology 707. In addition, all students are required to attend genetics seminars.

The requirements for the M.S. candidates will be a minimum of one course from each of any two of the above three groups of courses.

### Master of Science Degree

The program for the Master of Science degree is formulated by the student with the approval of the guidance committee. Candidates for the degree will be required to complete a thesis, pass an oral examination covering graduate courses and thesis, and complete courses designated in the core curriculum.

### Doctor of Philosophy Degree

The chairman of the Genetics Program, with the concurrence of the chairman of the department of major interest, will nominate the student's guidance and doctoral committees which will administer the qualifying and final examinations. Specific course requirements will be developed by the student and the guidance committee, and will include the courses in the core curriculum. Students must complete a dissertation on original research in genetics.

A student must satisfy a foreign language requirement by demonstrating proficiency in one language through successful completion of a Graduate School Foreign Language Test administered by Educational Testing Service.

#### 705. POPULATION GENETICS

Population growth and regulation; the distribution of genes in populations; factors affecting gene frequency such as mode of inheritance, mating systems, mutation, migration, genetic drift, selection, and linkage disequilibrium; genetic load, cost of natural selection, and ecological genetics. Mr. Kiang. Prerequisite: Zoology 604, Principles of Genetics; and Forest Resources 528, Applied Statistics I; or equivalents, or permission of instructor. 4 lec/4 cr. (Alternate years; offered 1976-77.)

#### 706. GENETICS LABORATORY

Experiments and demonstrations in classical, developmental, and population genetics and cytogenetics, utilizing a wide range of organisms and techniques. Genetics faculty. Prerequisite or concurrent: Zoology 604, Principles of Genetics, or equivalent, and permission of instructor. 2 cr.

#### 740. EVOLUTIONARY BIOLOGY

The synthetic theory of evolutionary processes in the origin of life, species, and higher groups; sources of genetic variability, population structure, causes of evolution; ecological adaptations in animals, plants, and man; evolution of communities; molecular evolution and rate of evolution. Mr. Kiang. Prerequisite: Zoology 604, Principles of Genetics, or equivalent, or permission of instructor. 4 lec/4 cr. (Alternate years; offered 1975-76.)

#### 770. BIOCHEMICAL GENETICS

The biochemical mechanism of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Mr. Green. Prerequisite: Biochemistry 751 or permission of instructor. 3 lec/1 lab/4 cr. (Alternate years; offered 1975-76.)

#### 802. DESIGN OF EXPERIMENTS

The philosophy of experimental design and how it relates to standard statistical designs. Topics include the roles of replication and randomization, factorially arranged treatments, latin squares, incomplete non-factorial designs, fractional replication and confounding, and cross-over designs. Mr. Urban. Prerequisite: Forest Resources 711; and Mathematics 410, Digital Computer Systems; or permission of instructor. 3 cr. (Alternate years; offered 1975-76.)



## 812. ADVANCED STATISTICAL METHODS

Methods and techniques for handling typical problems which arise in the analysis of data. Topics include the multiple comparison of means, analysis of unweighted means, proportional subclass numbers, weighted squares of means, orthogonal polynomials, and least squares. Mr. Urban. Prerequisite: Forest Resources 711 and Mathematics 410. Digital Computer Systems; or permission of instructor. 3 cr. (Alternate years; offered 1976-77.)

## 895-896. SPECIAL TOPICS IN GENETICS

Intended for study in specialty areas not ordinarily included in other courses. May involve formal classes, discussions, or independent investigations. Prerequisite: permission of staff concerned. 2-4 cr.

## (898) 898. GENETICS SEMINAR

Presentation and discussion of selected genetic topics. Staff. 1 cr. May be repeated.

## 899. MASTER'S THESIS

6-10 cr.

## 999. DOCTORAL RESEARCH

## Courses Available in the Cooperating Departments

These courses are fully described below and under the course descriptions of the appropriate department for the convenience of the student.

### Animal Sciences (17)

#### 711. COMPARATIVE ANIMAL GENETICS

How heredity affects domestic animals, poultry, other mammals, and fish; emphasis on the organism and population. Quantitative inheritance, principles of selection, disease resistance, also studied. Statistical and experimental techniques. Prerequisite: 4 cr. of genetics or permission of instructor. Mr. Collins. 3 lec/1 lab/4 cr.

#### 812. QUANTITATIVE GENETICS AND SELECTION

Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, and correlated characters. Mr. Collins. Prerequisite: one course each in genetics and statistics. 3 cr. (Alternate years; offered in 1975-76.)

### Forest Resources (21)

#### 711. STATISTICAL METHODS II

Intermediate course in statistics; basic concepts of sampling, linear models and analyses for one-way and multiway classification, factorial arrangement of treatments, multiple regression, and covariance. Prerequisite: INER 528 or equivalent. Mr. Barrett. 4 cr.

#### 720. FOREST REGENERATION AND TREE IMPROVEMENT

Improvement of forest stands through control of seed source and tree breeding. Artificial regeneration, seed production, variation in natural populations, selection of desired characters, and breeding methods. Prerequisite: For. Res. 527 and 629, or permission of instructor. Mr. Adams. 2 lec/1 lab/3 cr. (Alternate years; offered 1975-76.)

### Microbiology (70)

#### 804. MICROBIAL GENETICS

Expression, regulation, recombination, and transmission of genetic information in procaryotic and eucaryotic microorganisms. Consideration of chromosomal and extrachromosomal inheritance. Prerequisite: Micro. 503 and permission of instructor. 2 lec/1 lab/4 cr. (Alternate years; offered 1976-77.)

### Plant Science (24)

#### 732. PLANT DEVELOPMENTAL GENETICS

Gene action in relation to development in plants; isozymes and differentiation; chromosomal proteins and gene regulation; temporal specificity of gene action; nuclear-cytoplasmic interactions; chemical gradients and gene activation. Prerequisite: introductory genetics and physiology. 3 lec/1 lab/4 cr. (Alternate years; offered 1975-76.)

#### 773. METHODS AND THEORY OF PLANT BREEDING

Plant breeding systems for qualitative and quantitative plant improvement. Prerequisite: P.S. or Zoology 604, Forestry 528; or permission of instructor. Mr. Pierce. 3 lec/3 cr. (Alternate years; offered 1976-77.)

#### 851. PLANT GENETICS

Linkage, euploidy, aneuploidy, cytoplasmic inheritance, mutation, and genetics of disease resistance. Mr. Dunn. Prerequisite: Genetics. 3 cr. (Alternate years; offered 1975-76.)

## German and Russian

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### 853. CYTOGENETICS

Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory technique in cytogenetic analysis. Mr. Rogers. Prerequisite: Genetics and Cytology. 2 lec/1 lab/3 cr. (Alternate years; offered 1976-77.)

### Zoology (84)

### (707). HUMAN GENETICS

Inheritance patterns, gene and chromosome mutation rates and effects, linkage, and gene frequency. Prerequisite: Zoo. 604 or equivalent or permission of instructor. 4 cr.

## German and Russian (66 & 67)

**Chairman:** Michael J. Rosenbush

**ASSOCIATE PROFESSORS:** Marron C. Fort, Helmut F. Pfanner

**ASSISTANT PROFESSORS:** Roger S. Brown, Michael J. Rosenbush, James L. Sherman

**DIRECTOR OF STUDIES ABROAD:** James L. Sherman

The Department of German and Russian offers a program of graduate study in German leading to the degree of Master of Arts.

The graduate program is offered only through the German Summer School of the Atlantic, which represents a new approach in educating teachers of German in American secondary schools and universities and combines the resources of UNH with the experience of the Goethe Institute of Munich, Germany. The program is designed to meet such needs as: conversational mastery, teaching skills, and transfer credit for students with varied backgrounds in advanced German. The courses are offered only in the summer and are selected to provide a well-balanced program for the degree in a minimum of four summers.

This program provides the opportunity to master spoken and written German in a concentrated form which cannot be offered by most foreign universities.

To be admitted to graduate study, a student must have completed an undergraduate major in German. The Advanced Test in German of the Graduate Record Examination—unless taken earlier—is to be taken before the end of graduate studies. Students who have not had German 781, History and Development of the German Language, or its equivalent, must take it before completing graduate studies. It is required that students have a superior command of spoken and written German and be able to demonstrate knowledge of a second, modern, foreign language.

To satisfy the requirements for the degree of Master of Arts, the student must: 1) successfully complete ten courses including two seminars, or 2) complete eight courses successfully and write a master's thesis. The candidate must also pass the departmental comprehensive examination based upon the master's reading list.

A student may take up to 12 credits of graduate study at the University of Salzburg. The student should consult with the director of studies abroad.

Courses numbered 700-799 are for graduates and advanced undergraduates.

Courses numbered 800-899 are open only to graduate students. In rare instances, an undergraduate may be admitted with the permission of the instructor and the department chairman. Graduate students must take a minimum of three courses at the 800 level.

### 725. HISTORY OF GERMAN-SPEAKING COUNTRIES

A survey of the political, ethnological, and economic history of Germany, Austria, and Switzerland. Offered only in the summer. 4 cr.

### 726. GERMAN CULTURE AND CIVILIZATION

Historical, social, artistic, and folkloristic developments in German-speaking countries from the beginnings to the present. 4 cr.

### 771. INTRODUCTION TO MEDIEVAL GERMAN LITERATURE

Reading and critical analysis of selected works of the German High Middle Ages. Texts will be studied in the original and in modern German translation. Offered only in the summer. 4 cr.

### 772. GERMAN LITERATURE OF THE ENLIGHTENMENT

Literature and criticism of the eighteenth century, including Gottsched, the Swiss critics, Lessing, Wieland, and the "Sturm und Drang." Offered only in the summer. 4 cr.

### 773. CLASSICAL PERIOD IN GERMAN LITERATURE

Reading and critical analysis of selected works; emphasis on Goethe and Schiller. Offered only in the summer. 4 cr.

### 774. GERMAN ROMANTICISM

The Romantic movement in German literature from W. Schlegel to Eichendorff including contemporary writers outside the Romantic school, such as Kleist and Hölderlin. Offered only in the summer. 4 cr.

### 775. THE AGE OF REALISM

The outstanding prose and lyrics of Keller, Meyer, Storm, Fontane, and others. Offered only in the summer. 4 cr.

## 776. GERMAN LITERATURE FROM NATURALISM TO EXPRESSIONISM

Major literary movements between 1880 and 1925 including such authors as Hauptmann, Wedekind, Mann, Hesse, Kafka, Rilke, and Benn. Offered only in the summer. 4 cr.

## 777. GERMAN LITERATURE FROM 1918 TO 1948

The literature of Germany between the two world wars as well as German exile literature including Brecht, Doebelin, Zuckmayer, Musil, Broch, Graf, and others. Offered only in the summer. 4 cr.

## 781. HISTORY AND DEVELOPMENT OF THE GERMAN LANGUAGE

The changes in sounds, structure, and vocabulary from the earliest record to the present. Required for German majors. 4 cr.

## 792. METHODS OF TEACHING GERMAN

A critical study of modern language teaching at all levels from the elementary school through college. The course emphasizes the use of the most modern equipment, including films, tapes, and other audio-visual aids. Offered in the summer only. 4 cr.

## 795, 796. SPECIAL STUDIES IN GERMANIC LANGUAGES, LITERATURE, AND CULTURE

Topics to be arranged. Variable to 4 cr. Normally 2 credits counting as ½ course. Examples of typical courses taught are: Bibliography and Methodology, Influence of German Philosophy on Literature, Phonology, The Structure of Modern German, Renaissance, Baroque, "Biedermeier," Buchner. Offered only in the summer.

## 878. CONTEMPORARY GERMAN LITERATURE

Literary trends since 1948 in the two German states as well as in Austria and Switzerland including such authors as Boll, Johnson, Celan, Frisch, Durrenmatt, Weiss. Offered only in the summer. 3 cr.

## 885-886. GRADUATE STUDIES ABROAD

A program of studies at the University of Salzburg, Austria, for students who have been admitted to the Graduate School of the University of New Hampshire. Students should consult with the director of the Studies Abroad program.

## 888. SEMINAR

An intensive study of a literary group or figure or a topic dealing with German culture. Offered only in the summer. 3 cr.

## 895. SPECIAL STUDIES IN GERMAN LANGUAGE AND LITERATURE

Presuming a sound background in Germanic studies, this allows the student to investigate independently and in depth a vast range of subjects. Barring duplication of material, this course may be repeated for credit. Offered only in the summer. 3 cr.

## 899. MASTER'S THESIS

6 cr.

# History (68)

Chairman: Robert M. Mennel

PROFESSORS: William Greenleaf, Hans Heilbronner, Charles A. Jellison, William R. Jones, David F. Long, Darrett B. Rutman, Cecil J. Schnee

ASSOCIATE PROFESSORS: Charles E. Clark, Robert C. Gilmore, Marion E. James, Allen B. Linden, Frank D. McCann, Robert M. Mennel, Marc L. Schwarz, John O. Voll, Douglas L. Wheeler, Donald J. Wilcox

ASSISTANT PROFESSORS: Thomas M. Kemnitz, Judith A. Silver

DIRECTOR OF GRADUATE STUDIES: Donald J. Wilcox

## Admission

The department usually requires completion on an undergraduate level of the equivalent of a history major at this University (eight semester courses in history) together with some preparation in other areas of the humanities and social sciences.

Applicants for admission to any graduate program in history should have a minimum of B+ average in history and allied humanities and social sciences. In addition applicants must submit Aptitude (verbal and quantitative) and Advanced History scores on the Graduate Record Examinations. The department, however, reserves the right to assess the student's entire application, including non-quantifiable elements such as letters of recommendation, in making its recommendation on admission. Deficiencies in an undergraduate program may be rectified by course work as a special student but such course work cannot be used to satisfy requirements for an advanced degree. The department also recommends that a beginning graduate student have some training in a foreign language. It should be noted, however, that students who expect to participate in

# History

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seminar or reading courses in other than American history are usually required to have a reading knowledge of at least one foreign language appropriate to the particular course. Applicants intending the Ph.D. degree should include with their applications a personal statement indicating their reason for and intentions in undertaking graduate study at New Hampshire.

All graduate students are reviewed annually by the faculty of the department. A student accumulating two course failures is automatically barred from continuing in any degree program in history, but the department reserves the right to exclude others whose overall performance does not give reasonable assurance of a successful program completion. Students are allowed no more than three attempts to meet any language requirements.

## Degree Programs

The department offers the Master of Arts and Doctor of Philosophy degrees. The general degree requirements are outlined below, but specific programs are tailored to the goals of the student. The director of graduate studies of the department serves as the initial adviser to entering graduate students, the adviser-of-record to all students throughout their years of graduate study, and, with the Graduate Committee of the department, has general supervision of all student programs. By the beginning of a student's second semester in residence, the student intending a degree will ordinarily have selected a single member of the faculty as the program chairman and, with that faculty member as principal adviser, will have worked out a specific program of studies leading toward a degree.

The director of graduate studies must approve the registration of special students and students from other departments in graduate history courses. The department welcomes the opportunity to work with students from other departments.

A student's thesis-examining or guidance committee, as described below, is nominated by the director of graduate studies with the consent of the program chairman and is appointed by the dean of the Graduate School.

### Master of Arts

The student intending the M.A. degree has the option of designing a specific program to meet either of two sets of requirements; the first allows substantial training and research in a single subfield of history but within a foundation of broader coursework; the second allows substantial breadth over at least two subfields. The subfields in history are as follows: The Ancient World; Medieval Europe; Early

Modern Europe; Modern Europe; European Intellectual History; Medieval England; Early Modern England; Modern England; Russia; Early American History; Modern American History; Colonial Latin America; Modern Latin America; The Far East; The Near East; Sub-Saharan Africa; and the History of Science.

Completion of the degree under either set of requirements normally requires between three and four semesters of full-time study (three to four courses per semester). Either option may prepare a student for entrance to the Ph.D. program. Option B is particularly recommended for practicing teachers.

**Option A:** The student shall complete successfully at least eight courses in history numbered above 700, of which a minimum of four shall be numbered between 800 and 898 (seminar and directed readings). In addition, the student shall prepare within the context of any single subfield a thesis meriting the unanimous approval of a Thesis Committee consisting of the student's program chairman, under whose direction the thesis shall be prepared, and two other members of the graduate faculty (at least one of them in history). The preparation of the thesis is considered to be the equivalent of two additional semester courses each bearing the designation History 899 for the purpose of meeting the general regulations of the Graduate School. Three copies of the completed thesis, prepared in conformity with Graduate School regulations, shall be submitted to the reading committee no later than six weeks prior to the Commencement at which the degree is to be granted, and to the director of graduate studies for signature subsequent to approval by the committee and prior to submission to the Graduate School.

**Option B:** The student shall complete successfully at least ten courses in history numbered above 700 of which a minimum of four shall be numbered between 800 and 898. Following completion of course work, or during the final semester of course work, the student shall demonstrate a broad competence in two subfields of history ordinarily in oral examination before a committee of three consisting of the student's program chairman and two other members of the faculty in history. Students proceeding under Option B shall have stood examination no less than three weeks prior to the Commencement at which the degree is to be granted.

Students should note that Option A thesis readings and Option B examinations are available during the summer, only with the consent of all faculty involved.

## Doctor of Philosophy

The department offers work leading toward the degree Doctor of Philosophy with concentration in either of the two subfields of American history: Early America or Modern America. The degree is not essentially a course-related degree but is awarded in recognition of high attainment and ability in history as shown by performance in qualifying examination and by the preparation and defense of a dissertation. Normally, a student intending the doctorate who enters without an M.A. in history will complete an M.A. by way of prerequisite and include any of the following not part of undergraduate training: language training to the extent of competence in one foreign language and surveys of American and European historiography equivalent to History 723 and 774. Language proficiency is to be demonstrated by examination administered by the Graduate Student Foreign Language Testing Service, Princeton, N.J., or, if practicable, by a member of the faculty in history. A student in residence may, with the consent of the department, omit the M.A. and proceed directly toward the Ph.D.

The doctoral student's cardinal intellectual relationship is with the specific member of the faculty under whom the student will write the dissertation and who serves as the student's program chairman.

This relationship should be established early and a broad program supportive of the intended area of dissertation research worked out in consultation with the program chairman. The program, which must be approved by the Graduate Committee of the department, shall involve each of the following: 1) a second language or a special research technique, which ever is deemed most relevant to the area of research; 2) the entirety of American history with accent upon either of the subfields of Early and Modern America; 3) two subfields outside of American history; and 4) a cognate field outside of history entirely or a subfield of non-western history.

The preparation of the student for qualifying examinations will be guided by representatives of each subfield or cognate field specified. These representatives, as nominated by the director of graduate studies in consultation with the student and program chairman and appointed by the dean of the Graduate School, will constitute the student's Guidance and, subsequently, Examining and Dissertation Committees. Preparation for qualification will normally entail the completion of sixteen semester courses or more (including work undertaken in a master's program) and will require three years of study beyond the bachelor's degree, the greater portion of which is ordinarily accomplished in full residence.

The qualifying examinations will test the student's mastery of broad subfields of historical knowledge rather than of particular courses. Therefore, the student is expected to read widely and independently in order to expand his knowledge beyond formal course work.

The student should progress toward degree in six successive steps. (It is expected that University registration will be maintained during all regular academic semesters the student is in progress.) The steps are:

- 1) The removal of any existent deficiencies in the undergraduate or master's program.
- 2) The demonstration of proficiency in a second language or a special research technique. (Departmental regulations regarding the latter are available from the director of graduate studies.)
- 3) Successful performance in a two-part qualifying examination: the first part, a four-hour written examination covering breadth of knowledge in the subfield of specialization (Early or Modern American history); the second part, oral and covering all subfields and (if any) the cognate field specified in the program.
- 4) Within the same semester as Step Three, admission to candidacy and the approval by the candidate's Dissertation Committee of the specified topic and research plan for the dissertation.
- 5) Submission of an acceptable dissertation no more than three years after the admission to candidacy.
- 6) Successful public defense of the dissertation before the Dissertation Committee.

## Apprenticeship

The department considers that graduate work in history, and particularly doctoral work, is professional training. All entering graduate students intending a Ph.D. are, consequently, required (and all others are urged) to participate on a continuing basis in History 801, Proseminar: History as a Profession. Moreover, the department recognizes the dual concerns of the historian's life—teaching and research; when feasible, therefore, all doctoral students are expected to undertake teaching in the department during a part of their residence. Participation in proseminar and in teaching constitutes an apprenticeship in conjunction with formal study.

## Courses

### 703. THE COLONIAL PERIOD OF AMERICAN HISTORY

Interpretative and methodological approach to the development of an Anglo-American culture along the eastern seaboard of North America 1600-1750. 4 cr.

# History

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## **705, 706. AMERICA IN THE 18th CENTURY AND THE REVOLUTION**

American colonial and revolutionary history from 1740 through the adoption of the Constitution and the establishment of Washington's first administration. 4 cr.

## **711, 712. 19th CENTURY AMERICA**

Domestic and international factors in the development of the American Republic, its institutions and people, from the inception of the new nation in 1789 to the emergence of the United States as a world power in 1900. 4 cr.

## **715, 716. 20th CENTURY AMERICA**

United States history since 1896, from the triumph of industrialism on the national scene to the emergence of America as a world power in the nuclear age. Political, economic, and diplomatic developments. 4 cr.

## **719, 720. THE FOREIGN RELATIONS OF THE UNITED STATES**

Primarily the history of American diplomacy, with attention given to the non-diplomatic aspects. First semester: American Revolution to 1890; Second: 1890 to date. 4 cr.

## **721, 722. HISTORY OF AMERICAN THOUGHT**

Significant American thinkers considered in their social context. First semester: 1600 to 1860. Second semester: 1860 to the present. 4 cr. (Alternate years; offered 1976-77.)

## **723. AMERICAN HISTORIOGRAPHY**

From the Colonial period to the present. Historical writings about the American people and their immediate neighbors. Prerequisite: permission of instructor. 4 cr. (Alternate years; offered 1975-76.)

## **724. AMERICAN URBAN HISTORY**

The urbanization process from the Colonial period to the present. 4 cr.

## **731. LATIN AMERICAN HISTORY: REGIONAL OR COUNTRY STUDIES**

Seminar; readings and discussions of literature relative to region or country being studied. See department listing for the current semester's topic. Students will be guided through preparation of a research proposal. History 531-532 is recommended but not required. 4 cr.

## **732. LATIN AMERICAN HISTORY: TOPICAL STUDIES**

Thematic seminar; readings and discussions of literature relative to topic selected. See the department listing for the current semester. Students will be guided through preparation of a research proposal. History 531-532 is recommended but not required. 4 cr.

## **739, 740. THREE MEDIEVAL CIVILIZATIONS**

The demise of classical antiquity in the lands bordering the Mediterranean and the genesis and fruition of three new cultural traditions: Latin Christian, Islamic, and Byzantine. Religious, literary, and scholarly survivals and innovations from 400 A.D. to 1400 A.D. 4 cr.

## **741. THE AGE OF THE RENAISSANCE**

The Renaissance from 1300 to 1600 stressing intellectual and cultural history and concentrating on events in Italy; aspects of northern Europe will also be covered. 4 cr.

## **742. THE AGE OF REFORMATION**

Northern Europe from 1300 to 1600, stressing the intellectual and cultural aspects of the European Reformation. Concentrates on the 16th century but important trends in the 14th and 15th centuries will be given considerable attention. 4 cr.

## **747. 18th CENTURY FRANCE: THE OLD REGIME**

How France changed from a society in which bonds were local to one in which noble and peasant alike identified with the State. 4 cr.

## **748. 19th CENTURY EUROPE: SOCIAL UPHEAVAL AND POLITICAL CHANGE**

Tensions between social classes and their impact on protest and revolution. 4 cr.

## **751, 752. EUROPEAN INTELLECTUAL HISTORY**

The European intellectual tradition from the Greek philosophers to the end of World War II. How basic ideas have developed out of previous modes of thought in response to new challenges. 4 cr. (Alternate years; offered 1976-77.)

## **756. 20th CENTURY EUROPE**

World War I, European totalitarianisms, World War II, the loss of European primacy, and the search for a new Europe. 4 cr.

## **(759). HISTORY OF MODERN SPAIN AND PORTUGAL**

The Iberian states and their peoples from the coming of liberalism to the present. Failure of Iberian liberalism and liberal government. Political and social change, imperial and intellectual movements, influences of Western European thought and activity. 4 cr.

## **761,762. ENGLAND IN THE TUDOR AND STUART PERIODS**

The political, religious, socio-economic, and intellectual forces for change at work in England from the accession of Henry VII to the Revolution of 1688-89. 4 cr.

## **763. RUSSIA: ORIGINS TO MODERNIZATION**

Russia from its foundation to Emancipation and Reform. Political developments, foreign relations, intellectual and ideological currents. 4 cr.

## **764. RUSSIA: FROM TSARIST TO SOVIET EMPIRE**

The costs of modernization, the Leninist and Stalinist revolutions, and Soviet consolidation. 4 cr.

## **767,768. HISTORY OF GERMANY**

From the Reformation to the Third Reich and the presently divided Germany. Emphasis on the relationship and importance of Germany to the rest of Europe. 4 cr.

## **771,772. MODERN ENGLAND**

From 1760 to the present. Social, intellectual, economic, and political transformation of the country as it developed into a major industrial nation and then adjusted to international and economic difficulties in the 20th century. 4 cr.

## **774. EUROPEAN HISTORIOGRAPHY**

Historical writing from the Greeks to the 20th century. Means of evaluating various types of historical writing, the intellectual context of the historians, and the effect of this on their work. Methodology and philosophy of history will not be directly treated. 4 cr.

## **777,778. THE HELLENISTIC-ROMAN WORLD**

The Mediterranean and the Near East from the death of Alexander the Great to the collapse of the Roman and Persian Empires (5th to 7th centuries A.D.). Covers the main political and social developments of the area, but stresses artistic, scientific, philosophical, and religious trends, with particular emphasis on the rise of Christianity, Zoroastrianism, and the general religious climate that prepared the way for Islam. 4 cr.

## **(781). HISTORY OF MODERN CHINA, 1839-PRESENT**

The modernization of China. The political, social, and cultural changes which have occurred in China from its early contacts with the West. 4 cr.

## **784. HISTORY OF SOUTHERN AFRICA SINCE 1820**

The struggle for political and economic control in the only region of Africa where European groups remain in power. The impact of European imperialism, European settler nationalism, racial conflict, economic competition and industrialization, apartheid, and assimilation with special attention to the development of European hegemony. Official American policy. 4 cr.

## **(785). THE MODERN MIDDLE EAST**

From the 18th century to the present time. The problems created by modernization and reform of the traditional society, the conservation reaction to reform, the impact of nationalism, and the appearance of new ideologies. 4 cr.

## **(787). BLACK CONSCIOUSNESS AND PROTEST**

Origins and causes of the rising consciousness and consequent activism of the peoples of Negro descent in the New World and in Africa from the early nineteenth century to the present. Protest literature, black nationalism, Pan-Negroism, Pan-Africanism, negritude, the Nation of Islam, and separatist religious sects in the Americas and Africa. Cross-cultural and multidisciplinary. 4 cr.

## **(789). SEMINAR IN THE HISTORY OF SCIENCE**

Selected topics conducted through special lectures, individual study, oral and written reports. Subject varies. Cannot be used for credit in history without permission of the department. Prerequisite: permission of adviser and instructor. 4 cr.

## **790. QUANTIFICATION AND COMPUTERS FOR THE HISTORIAN**

The historian's use of computers and statistics; practical applications of both interactive terminal operations and batch processing. Data generation and processing, computer languages (BASIC, FORTRAN), programming and library programs, elementary statistics; students will undertake operations of their own on material supplied and will consider particular quantitative studies in history in terms of techniques used. No previous knowledge of computers or college mathematics required. Prerequisite: admission as an undergraduate major or graduate student in history, or permission of instructor. 4 cr.

# History

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## **791. HISTORY-EDUCATION—PROBLEMS IN THE TEACHING OF HIGH SCHOOL HISTORY AND OTHER SOCIAL STUDIES**

Bibliography and new interpretations of history; the curriculum, past and present; aims and objectives; selection and organization of teaching material; teaching and testing techniques. Special emphasis on teaching American history and the problems of American democracy. May not be used to satisfy major requirements. 4 cr.

## **793. ADVANCED WORLD HISTORY**

History from the perspective of the experience of the whole human community. The histories of separate areas in terms of their relationship to the general historical experience of man. Problems of interpretation, interrelationships, similarities, and differences in the development of the major traditions of civilization. Oral and written reports. 4 cr.

## **797 (797). COLLOQUIA IN HISTORY**

Selected topics in American, European, and non-Western history. Open to advanced undergraduate and graduate students. Prerequisite: permission of instructor. Depending on the particular subject, may be used to satisfy the major requirements in American, European, or non-Western history. 4 cr.

## **Graduate Readings and Seminars**

Note that in any given semester any number of sections of a general seminar course (819 through 860) may be offered, the content and direction of a specific section depending upon the research interests of the faculty member directing the section. General seminar and reading courses, and particular sections, can be repeated as the section content changes. A full description of the current direction and content of each section offered in a given semester is available shortly before the semester from the department's director of graduate studies.

## **(801). PROSEMINAR: HISTORY AS A PROFESSION**

Entering graduate students intending the doctorate and all advanced graduate students serving as research, program, or teaching assistants in the department meet periodically to discuss the obligations and mechanics of the historian's profession, including teaching, scholarship, university and college structures, and the role of the faculty therein. No cr.

## **(819, 820). SEMINAR IN EARLY AMERICAN HISTORY**

1) Mr. Clark (Social and Cultural), 2) Mr. Gilmore (Revolution), 3) Mr. Rutman (Anglo-American Society). Prerequisite: permission of instructor. 3 cr.

## **(823, 824). SEMINAR IN AMERICAN NATIONAL HISTORY**

1) (Afro-American), 2) Mr. Greenleaf (Twentieth Century), 3) Mr. Jellison (Nineteenth Century and Biography), 4) Mr. Mennel (Social), 5) Mr. Long (Foreign Relations). Prerequisite: permission of instructor. 3 cr.

## **(836). SEMINAR IN LATIN AMERICAN HISTORY**

Topics will vary and will include: Conservatism and conformity in Latin America; the Portuguese Empire; Brazil and Africa; the Mexican Revolution; Nationalism and Neocolonial Latin America; Brazil: Empire and Republic; and Slavery in the Americas: a Comparison. Mr. McCann, 3 cr.

## **843, 844. SEMINAR/READINGS IN EUROPEAN HISTORY**

1) Mr. Heilbronner (Modern Russia), 2) Mr. Jones (Medieval), 3) Ms. Silver (France and European Social History), 4) Mr. Wheeler (Spain and Portugal), 5) Mr. Wilcox (Renaissance). 3 cr.

## **(859, 860). SEMINAR IN ENGLISH HISTORY**

1) Mr. Kemnitz (Nineteenth Century), 2) Mr. Schwarz (Tudor-Stuart). Prerequisite: permission of instructor. 3 cr.

## **888. PROBLEMS IN MODERN AFRICAN HISTORY**

Topics will vary each year the seminar is offered. Emphasis will be on Africa South of the Sahara in the colonial and post-colonial eras. Among the topics will be: African resistance movements in pre-colonial and colonial Africa; African nationalism; problems of the independent African states; the role of the military in post-colonial Africa; and issues in Portuguese African history. Students will write research papers and give oral presentations. Mr. Wheeler. 3 cr.

## **(895, 896). TUTORIAL READING AND RESEARCH IN HISTORY**

1) Early American History, 2) American National History, 3) Canada, 4) Latin America, 5) Medieval History, 6) Early Modern Europe, 7) Modern European History, 8) Ancient History, 9) Far East and India, 10) Near East and Africa, 11) European Historiography, 12) American Historiography, 13) Russia, 14) World History, 15) English History, 16) Historical Methodology. Staff. Prerequisite: permission of instructor. 3 cr.

## **(899). MASTER'S THESIS**

## **(999). DOCTORAL RESEARCH**



## Home Economics (22)

**Chairwoman:** Elizabeth Snell

**ASSOCIATE PROFESSORS:** M. Elizabeth Rand, Emeritus, Mary E. Holder, Elizabeth A. Snell

**ASSISTANT PROFESSORS:** Larry J. Hansen, Victor R. Messier, Judith A. Schickedanz

Graduate work is offered leading to the degree of Master of Science in Home Economics, with major emphasis in areas which strengthen professional competence in family, community, and educational services.

Each student's program will be planned to achieve personal and professional objectives of the individual and be based on specific interests, ability, and undergraduate preparation. Selection of courses from the social sciences and other University departments will be encouraged.

Students admitted to the graduate program in Home Economics are expected to have an undergraduate degree in Home Economics or a related field. If there are deficiencies in the undergraduate program, students may be admitted on condition that they complete specified prerequisites.

A candidate for a Master of Science degree in Home Economics is expected to fulfill the general requirements of the Graduate School and the following departmental requirements:

- 1) Home Economics—a minimum of 12 semester credits (700 level and above).
- 2) A minimum of eight semester credits selected from the liberal arts or other areas which support the major.
- 3) Research and Statistics—a minimum of eight semester credits, including Home Economics 897, Research Seminar; a course in statistics; and Home Economics 898, Research Project, or Home Economics 899, Thesis.

Each student must have his program approved by his/her advisor and the dean of the Graduate School.

### 707 (707). PRACTICUM WITH CHILDREN AND FAMILIES

Supervised experience with children or families, participation and observation, to increase the students' awareness and understanding of the ways human beings grow and behave, and the dynamics of the family. Choice of practicum from: 1) young children, e.g. preschool program; 2) school-age children; 3) adolescents; 4) children and parents; 5) consumer problems of families and individuals. Prerequisite: H.E. major and permission. May be repeated to maximum of 6 cr. in one area. 2 or 4 cr.

### (715). CLOTHING IN RELATION TO HUMAN BEHAVIOR

Research and theory in the social psychological aspects of clothing; clothing behavior of individuals and groups; stages of the life cycle, development of the self, and the phenomenon of fashion. 4 cr.

### 725 (725). PRESCHOOL PROGRAMS

Organization of time, space, materials, and people for the purpose of attaining goals in preschool education. Historical and current programs will be studied. Prerequisite: H.E. 627 or permission of instructor. 4 cr.

### 727. STUDENT TEACHING IN PRESCHOOL

Supervised teaching experience in a preschool setting. Students will spend five half days a week in a selected preschool working with a cooperating teacher. A weekly seminar will also be held on campus. Prerequisite: H.E. major—H.E. 525, 527, 626, 627, and permission of instructor. 6 cr.

### 754. PERSONAL AND FAMILY FINANCE

Financial alternatives available to individuals and families during stages of the family life cycle. 4 cr.

### 757. CONSUMER PROBLEMS

Consumer problems analyzed from the perspective of family, business, and government interests. Prerequisite: 8 cr. in consumer studies and permission of instructor. 4 cr.

### 774. CLINICAL DIETETICS

Principles of normal nutrition applied to clinical problems; altered nutrient requirements in human disease. Diet therapy as applied to clinical nutrition. Prerequisite: H.E. 573 and 506, a college course in biochemistry, and permission of instructor. 3 lec/1 lab/4 cr.

### (776). CONTEMPORARY ISSUES IN NUTRITION

Focus on national and worldwide nutrition concerns. Approaches and materials used in nutrition education. Prerequisite: H.E. 506, 573 or 575, permission of instructor. 4 cr.

### (786). DYNAMICS OF FAMILY CHANGE

Theories and research for the assessment of family interaction patterns; planned intervention techniques. Students examine their interaction processes and their possible effect on intervention efforts. Prerequisite: H.E. 683, Psychology 545. 4 cr.

## Institute of Natural and Environmental Resources

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### 791 (791). METHODS OF TEACHING HOME ECONOMICS

Home Economics in the school program; curriculum materials, methods, and resources in teaching. 4 cr.

### 793. SEX EDUCATION IN HOME, SCHOOL, AND COMMUNITY

Human sexuality; programs, materials, and methods for sex education. For students planning careers in teaching, nursing, or social work. Prerequisite: Biology 409 and permission of instructor. 4 cr.

### 883. HUMAN SEXUAL BEHAVIOR

An exploration of contemporary opinion and research on human sexual behavior and development. The implications for social welfare and education will be examined in light of available research and other scholarly studies. 4 cr.

### 893. PARENTS AND CHILDREN

An in-depth study of the reciprocal relationships among parents and children. Evaluation of service programs in terms of current research. Prerequisite: H.E. 626, 683 or permission of instructor. 4 cr.

### 895. SEMINAR AND SPECIAL PROBLEMS

The seminars are open to graduate students with sufficient background for in-depth study in any of the following areas: 1) clothing and textiles, 2) consumer education, 3) family relations, 4) food and nutrition, 5) home economics education, 6) management and family finance, and 7) human development. The student will contribute to a selective review and critical evaluation of the research and current literature and an examination of issues and trends. Independent projects may be a part of the experience. These seminars will not be scheduled every semester. One or more semesters, maximum of 4 credits in one area. 2 to 4 cr.

### 897. RESEARCH SEMINAR

Survey, evaluation, and use of research in the field of home economics. An introduction to methods and techniques used in defining a problem for study, collecting data, analyzing, and writing a report. 2 cr.

### 898. RESEARCH PROJECT

A study or project which may be selected in lieu of a thesis. To be taken concurrently with or following Home Economics 897. 2-4 cr.

### 899. THESIS

6 cr.

## Institute of Natural and Environmental Resources

**Director:** David P. Olson

**Chairman of Graduate Studies:** John L. Hill

**PROFESSORS:** Richard A. Andrews, James P. Barrett, James R. Bowring, Paul E. Bruns, Gordon L. Byers, William H. Drew, Francis R. Hall, William F. Henry, John L. Hill, Harold W. Hocker, Jr., Allan B. Prince

**ADJUNCT PROFESSOR:** George E. Frick, Nelson L. LeRay

**ASSOCIATE PROFESSORS:** Owen B. Durgin, Bennett B. Foster, Edmund F. Jansen, Jr., William W. Mautz, David P. Olson, Nobel K. Peterson, R. Marcel Reeves, Oliver P. Wallace, Sr., Richard R. Weyrick

**ADJUNCT ASSOCIATE PROFESSORS:** C. Anthony Federer, William B. Leak, Robert S. Pierce

**ASSISTANT PROFESSORS:** W. Thomas Adams, John E. Carroll, Sidney E. Feld, Robert D. Harter, H. Steven Logsdon, Douglas E. Morris

**ADJUNCT ASSISTANT PROFESSOR:** Peter W. Garrett

## Master of Science, Natural and Environmental Resources

A single master's degree is offered by the Institute with five specific options:

### Forest Resources

Forest resource management; forest recreation; forest marketing; wood industry management; forest mensuration; forest tree improvement; and wood science and technology.

### Hydrology

Hydrochemistry; ground water hydrology; evapotranspiration; and water conservation.

### Resource Economics

Agricultural economics; rural and community development; regional economics; land and water economics; rural manpower and population; economics of outdoor recreation; and marine economics.

### Soil Science

Soil chemistry; soil classification and genesis; soil-plant relationships; and soil conservation.

# Institute of Natural and Environmental Resources

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## Wildlife Ecology

Habitat evaluation and management; wildlife nutrition and physiology; and land-use planning for wildlife.

## Entrance Requirements

Students admitted to Institute programs in these options are expected to have completed either an undergraduate degree in the field in which they plan to specialize or show adequate preparation in the basic support courses of the field. Students with good undergraduate records who lack a background in a particular field may be admitted to a program, provided they are prepared to correct the deficiencies.

Students entering the Forest Resources option are usually expected to have completed a bachelor's degree in Forestry equivalent to that obtained at a school accredited by the Society of American Foresters. Students planning for the Resource Economics option will need satisfactory undergraduate training which includes two or more courses in economics or resource economics and a total of four or more courses in the social sciences. The Graduate Record Examination is also required of applicants to Resource Economics. Entering students in Hydrology and Soil Science are required to have adequate preparation in chemistry, physics, mathematics, and the biological or earth sciences. Students interested in Wildlife Ecology are expected to have adequate preparation in biological sciences, chemistry, and mathematics including statistics.

## Academic Requirements

The M.S. degree is conferred upon successful completion of the following:

1) A program amounting to not less than 30 credits, including the following course requirements or equivalent: INER 897-898 seminar, 2 credits; INER 803, Approach to Research, 2 credits; quantitative methods or analytical techniques; and directed research, 4-10 credits.

2) A final oral and/or written examination.

## Intercollege Cooperative Programs

The Institute participates in four doctoral degree programs on a cooperative basis with other departments in the University. The Department of Chemistry offers a Soil and Water Chemistry option in their Ph.D. program, which is coordinated through joint efforts of the Soils and Hydrology faculty and the Chemistry faculty (see Interdisciplinary Options and Programs). A Ph.D. program in Genetics is available to students in Forest Resources through the Genetics

Program (see Genetics Program). Students can earn a Ph.D. in Economics in the cooperative program with Resource Economics and the Whittemore School of Business and Economics (see Economics). Through informal cooperative arrangements with the Electrical Engineering and Mechanical Engineering departments, opportunities are available for graduate study in Wood Science and Technology in the College of Technology, leading to either the master's degree in Electrical Engineering or Mechanical Engineering or the Ph.D. degree in Engineering. (See Engineering Ph.D. Program: Theoretical and Applied Mechanics or Signal Processing.)

## Natural and Environmental Resources (27)

### 701 (701). STATISTICAL METHODS I

Analysis of variance and general linear models; measured numbers, the nature of statistical evidence, sampling distributions, and principles of statistical inference; application of specific linear models to given sets of data. Prerequisite: upper-division undergraduate or graduate standing. Mr. Durgin. 4 cr.

### 702. NATURAL RESOURCES POLICY

Contemporary issues in the management and allocation of natural resources; impact of man on agricultural and forest lands, water, wildlife, fisheries, and minerals; historical perspective of current resource policies. Prerequisite: permission of instructor. Mr. Bruns. 4 cr.

### 709. SOILS AND COMMUNITY PLANNING

Students study a "Town Plan" and soils map to develop individual reports of land use; introduction to the soils of New Hampshire; basic information on the U.S.D.A. soil classification system; the Soil Conservation Service criteria for rating soils for multiple use: housing, recreation, sewerage, effluent disposal, conservation, transportation, surface runoff, and other soil-use problems common to rural and urban communities. A representative of a town-planning firm and federal and state soil scientists are guest lecturers. Mr. Peterson. 2 lec/2 cr.

### 711. STATISTICAL METHODS II

Intermediate course in statistics; basic concepts of sampling, linear models and analyses for one-way and multiway classification, factorial arrangements of treatments, multiple regression, and covariance. Prerequisite: INER 528 or equivalent. Mr. Barrett. 4 cr.

# Institute of Natural and Environmental Resources

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## 712. SAMPLING TECHNIQUES

The techniques of sampling finite populations in environmental sciences; choice of sampling unit and frame, estimation of sample size, confidence limits, and comparisons of sample designs. Computer programs used in analyzing data. Examples taken from the environmental sciences. Prerequisite: INER 528 or equivalent. Mr. Barrett. 2-4 cr.

## 735. POLLUTION OF WATER: CAUSES AND CONTROL

Problems in environmental pollution; scientific and technological aspects of pollution and pollution control; sources, effects, and control of water pollution, and its social, economic, and legal implications. Prerequisite: senior or graduate standing. Mr. Harter. 2 lec and weekly papers/4 cr.

## 757. BASICS OF REMOTE SENSING

Application of photographic and non-photographic sensors to information gathering in natural resource fields; interpretation of aerial photographs. Applications to forestry, wildlife, land-use planning, earth sciences, soils, hydrology, and engineering. Transportation fee. Mr. Bruns. 1-hr lec/2-hr lab/2 cr.

## 758. APPLICATIONS OF REMOTE SENSING

Student project is developed using available conventional aerial photography or other imagery. Transportation fee. Prerequisite: INER 757 or equivalent. Mr. Bruns. 1-hr lec/2-hr lab/2 cr.

## 797. FOREST RECREATION SEMINAR

Recreational use of non-urban lands; economics of public and private developments; planning for state and private recreational use, social aspects. Class project. Prerequisite: junior standing and permission of instructor. Mr. Wallace. Two 1-1/2 hour sessions/4 cr.

## 803. APPROACH TO RESEARCH

The meaning of science and the scientific method. The application of logic in the scientific method. The general principles and techniques of scientific research. A general survey of statistical procedures as a tool for research. The organization of investigative work including problem analyses, working plans, and the preparation of reports. Mr. Drew, Mr. Hill. Prerequisite: permission of instructor. 2 cr.

## 815. LINEAR PROGRAMMING METHODS

Setting up and solving problems by the simplex and distribution methods; variation in linear programming methods with applications; non-linear programming, discrete programming; and solving input-output and game-theory problems. Applications to firm and aggregate economic analysis. Mr. Andrews. Prerequisite: Elementary Matrix Algebra or permission of instructor. 2 cr.

## 897, 898. NATURAL AND ENVIRONMENTAL RESOURCES SEMINAR

Presentation and discussion of recent research, literature, and policy problems in the natural and social sciences influencing resource use. Staff. May be repeated. 1 cr.

## Forest Resources (21)

### 720. FOREST REGENERATION AND TREE IMPROVEMENT

Improvement of forest stands through control of seed source and tree breeding. Artificial regeneration, seed production, variation in natural populations, selection of desired characters, and breeding methods. Prerequisite: For. Res. 527 and 629, or permission of instructor. Mr. Adams. 2 lec/1 lab/3 cr. (Alternate years; offered 1975-76.)

### 737. GAME MANAGEMENT I

Biological characteristics, habitat requirements, research and management practices of upland game birds and big game animals. Several all-day field trips required (possibly on weekends) to New England wildlife areas. Transportation fee. Prerequisite: wildlife management major or permission of instructor. Mr. Logsdon. 2 lec/1 rec/1 lab/4 cr.

### 738. GAME MANAGEMENT II

Biological characteristics, habitat requirements, research and management practices of small game animals, furbearers, predators, and waterfowl. Several all-day field trips required, (possibly on weekends) to New England wildlife areas. Transportation fee. Prerequisite: wildlife management major or permission of instructor. Mr. Logsdon. 2 lec/1 rec/1 lab/4 cr.

### 745. FOREST MANAGEMENT

Production control; management objectives; forest production regulation and economic analysis; forest administration; professional responsibilities and opportunities. Prerequisite: completion of junior year in forestry curriculum. Transportation fee. Mr. Weyrick. 3 lec/1 lab/4 cr.

# Institute of Natural and Environmental Resources

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## **753. OPERATIONS CONTROL AND ANALYSIS**

Some quantitative tools for decision-making in forest resource management activities; development and analysis of cost functions, timber and stumpage valuation, forecasting, linear programming, Monte Carlo simulation, PERT. Mr. Foster. 2 lec/1 lab/4 cr.

## **754. WOOD PRODUCTS MANUFACTURE AND MARKETING**

Wood products from harvesting and procurement of raw material to finished product processes; management decisions, marketing, and promotion problems. Visits to harvesting operations and manufacturing plants in New England. Transportation fee. Prerequisite: Forest Resources 426, or permission of instructor. Mr. Hill. 3 lec/1 lab/4 cr.

## **764. FOREST INDUSTRY ECONOMICS**

Business methods and economics in the forest industry; planning for minimum cost operations and profitable use of capital in a forest enterprise. Individual projects. Prerequisite: senior standing and permission of instructor. Mr. Wallace. 2 1-hour lec/1 lab/4 cr.

## **798. FOREST RESOURCES MANAGEMENT SEMINAR**

Population trends and human needs in relation to forest land productivity for timber, wildlife, water, recreation, and grazing. Class organized for group planning to maximize forest productivity for the State of New Hampshire. Prerequisite: Forest Resources 745. Mr. Wallace. 2 lec/1 lab/4 cr.

## **801. FOREST MANAGEMENT SEMINAR**

Seminar discussions of current literature, plans, and principles, and new developments in the general field of forest management. Mr. Bruns and members of the department. Prerequisite: permission of instructor. 2 cr.

## **805. UTILIZATION SEMINAR**

Conferences, discussions, and reports on assigned topics. Consideration of current literature and developments in the general field of wood utilization. Mr. Hill. Prerequisite: permission of instructor. 2-hour sem/2 cr.

## **806. OPERATIONS CONTROL SEMINAR**

Conferences, discussions, and reports on assigned topics. Considerations of current developments in the field of quantitative control of forest operations. Mr. Foster. Prerequisite: permission of instructor. 2-hour sem/2 cr. (Alternate years; offered 1975-76.)

## **809, 810. WILDLIFE MANAGEMENT SEMINAR**

Discussions and assigned reports on current investigations and developments in wildlife management. Mr. Olson, Mr. Mautz, and Mr. Logsdon. Prerequisite: undergraduate courses in wildlife management. 2-hour sem/1 cr.

## **816. QUANTITATIVE FOREST ECOLOGY SEMINAR**

Preparation, presentation, and discussion of recent topics in quantitative ecology such as remote sensing, population growth, competition between species, modeling of a population, and energy flow. The seminar is 2 credits with an additional 2 credits available for an in-depth study of a particular topic. Mr. Leak and Mr. Barrett. 2-4 cr.

## **834. FOREST PROTECTION SEMINAR**

Discussion and special problems based on principles and techniques of forest protection. Mr. Weyrick. Prerequisite: Forest Resources 660, Forest Protection, or courses in entomology or plant pathology. 3 cr.

## **895, 896. INVESTIGATIONS IN 1) FOREST ECOLOGY, 2) PHOTOGRAMMETRY, 3) WOOD UTILIZATION, 4) GAME MANAGEMENT, 5) MENSURATION, 6) FOREST ECONOMICS, 7) FOREST MANAGEMENT, 8) OPERATIONS CONTROL AND ANALYSIS, 9) RECREATION, 10) POLICY, 11) WILDLIFE PHYSIOLOGY**

Elective only after consultation with the instructor in charge. 1-4 cr.

## **899. THESIS**

Hours and credits to be arranged to meet the needs of the individual student. Prerequisite: graduate standing and permission of instructor in the selected field of study. 6-10 cr.

## **Resource Economics (25)**

### **705. PLANNED CHANGE IN NON-URBAN COMMUNITIES—APPLICATION**

Application of community development theory, concepts, and principles using appropriate research methodologies. Students participate in community-development activities, and discuss problems and report on findings, experience, and progress in weekly seminars. May include placement in field agency or institution. Prerequisite: Res. Econ. 508 or permission of instructor. Mr. LeRay. 4 cr.

# Institute of Natural and Environmental Resources

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## **706. ECONOMICS OF RESOURCE DEVELOPMENT**

Classical and modern theories of economic development, and the major resource development problems of New England, problems of land and resources in relation to market location, urban-rural conflicting demands, and conservation and water supply; population mobility, capital needs, and the roles of public and private leadership. Prerequisite: intermediate economic theory. 4 cr. (Alternate years; offered in 1975-76.)

## **707. RESEARCH METHODS IN SOCIAL SCIENCE**

Scientific method; analysis of problems; design and application of research techniques. Can be used in place of Sociology 702. Prerequisite: three hours of statistics. Mr. Drew. 4 cr.

## **717. LAW OF COMMUNITY AND REGIONAL PLANNING**

Common law, the Constitution, and powers of the executive, legislative, and judicial branches with respect to property law including eminent domain, land-use planning, urban renewal, zoning, environmental protection laws, housing and building codes, etc. Designed to make the non-lawyer aware of the influence and operation of the legal system in communities to enable individuals to deal with competing interests within it. Mr. Tucker. 4 cr.

## **756. REGIONAL ECONOMIC ANALYSIS**

Concepts and methods of delimiting regional economies, theories of growth, methods of measuring activity, regional development, and policies. Empirical research studies. Prerequisite: intermediate economic theory, elementary statistics, calculus, linear programming, or permission of instructor. Mr. Morris. 4 cr.

## **804. APPLIED ECONOMICS OF RESOURCE USE**

The theory of resource allocation used in solving public and private economic problems. Resource-product relationships, nature of cost, returns to scale, factor valuation and pricing, and uncertainty are analyzed with appropriate methodology. Primary emphasis will be placed on empirical research studies and their implications. Mr. Andrews and Mr. Morris. Prerequisite: INER 701 or equivalent, and Economics 605 or equivalent. 4 cr.

## **807. STATISTICAL ANALYSIS**

Statistical measurement and research tools for use in the physical and social sciences. Regression, analysis of variance, factorial analysis, covariance, time series, sampling, and experimental design. 4 cr.

## **809. AGRICULTURAL ECONOMICS**

Analysis of supply, demand, and price relationships. Appraisal of the economic theory relevant to decision-making in food production, marketing, and consumption, and on the competitive structure of the food industry. Mr. Henry. 4 cr.

## **820. ENVIRONMENTAL ECONOMICS SEMINAR**

The use of economic concepts for analyzing current environmental problems. Student reports and class discussion will deal with the application of economic analysis to real world environmental problems at the local, state, and national levels; costs and benefits of alternative methods of dealing with environmental objectives; and other economic goals of society. Mr. Andrews, Mr. Jansen, Mr. Morris, and Mr. Henry. Prerequisites: Economics 605 and 611, or equivalent, and permission of instructor. 2 cr.

## **838. INTRODUCTION TO THE LOCATION OF ECONOMIC ACTIVITY**

Economic theories explaining the behavior of individual firms and consumers in selecting sites for carrying on economic activities. The relationship of these theories to patterns of industrial location, systems of cities, and land-use competition in general. Problems of locational change and adjustment and the effects of public policy on spatial economic activities. Mr. Morris. Prerequisite: elementary calculus, linear algebra, regression, micro- and macro-economics or permission of instructor. 4 cr. (Alternate years; offered 1975-76.)

## **895, 896. INVESTIGATIONS IN RESOURCE ECONOMICS**

Special assignments in readings, investigations, or field problems. May be repeated. 1) Community Development, 2) Economic Development Programs, 3) Economics of Natural Resources, 4) Human Resource Development, 5) Legal Problems of Resource Development, 6) Natural Resources Policy, 7) Production and Marketing of Agricultural Products, 8) Public Resource Policy, 9) Resource Investment Policy, 10) Water Economics. Prerequisite: permission of instructor. 2-4 cr.

## **899. THESIS**

To be arranged. 6-10 cr.

## Soil and Water Science (26)

### 701. PHYSICS OF SOILS

Soil as a physical system; textural and structural analysis of soils, water flow and retention, and heat and gas transfer; the physical properties of soil and plant growth; methods of soil physical analysis. Prerequisite: SWS 501 or permission of instructor. 3 lec/1 lab/4 cr.

### 702. CHEMISTRY OF SOILS

Chemical composition and use of soils; colloidal phenomena and the exchange and fixation of elements; cation exchange, capacity and source of negative charge, soil acidity, the chemistry of nitrogen and phosphorus in the soil. Prerequisite: one year of college chemistry or permission of instructor. Mr. Harter. 3 lec/3 cr.

### 703. SOIL AND WATER ENGINEERING

Engineering principles, and the control of water; precipitation and stream-flow measurement, hydrograph development, estimating run-off from a watershed, and the design of structures to control this run-off. Instrumentation and problem analysis. Mr. Hall. 3 lec/1 lab/4 cr.

### 704. SOIL CLASSIFICATION AND MAPPING

Soil genesis, morphology, classification, and mapping; major classification systems used in the U.S. and throughout the world as they relate to man's uses of the soil. Transportation fee. Prerequisite: SWS 501 and an introductory geology course, or permission of instructor. Mr. Peterson. 3 lec/1 lab/4 cr.

### 705. PRINCIPLES OF HYDROLOGY

Physical and chemical processes and energy relations involved in the rainfall-runoff segment of the hydrologic cycle; surface outflow from a watershed with consideration given to sediment transport and water quality. Flow measurement, hydrometeorologic measurements, and hydrograph analysis. Mr. Hall. 3 lec/1 lab/4 cr.

### 710. GROUND-WATER HYDROLOGY

Principles governing occurrence, location, and development of ground water; well hydraulics, geophysical exploration, and chemical quality of water; use of fluid and electrical models, geophysical instruments, and selected problems. Basic course for hydrology majors and other qualified students. Mr. Hall. 3 lec/1 lab/4 cr.

### 802. CHEMISTRY OF SOIL COLLOIDS

Physical chemistry of soil colloids and soil colloidal phenomena. Major topics include: electric double-layer theory, solid-solution interfacial reactions, surface acidity, theories of swelling, ionic diffusion in soil. Mr. Harter. Prerequisite: one year of physical chemistry or permission of instructor. 3 lec/3 cr.

### 803. ADVANCED HYDROLOGY

Provides a background for graduate students interested in water resource systems. Application of quantitative methods to selected problems in water resources. Major topics include ground-water flow, stream-aquifer relations, rainfall-runoff process, and water quality. Particular emphasis is placed on the approach of conceptualizing the problem, developing an appropriate model, and obtaining solutions by digital or analog simulation. Mr. Hall. 3 cr.

### 804. HYDROCHEMISTRY

The chemical principles for dilute aqueous solutions at relatively low temperatures and pressures are applied to the study of fresh waters at or near the earth's surface. Major topics include equilibrium concepts, buffering mechanisms, oxidation-reduction reactions, and ion exchange. Particular emphasis is given to selected systems involving water, carbon dioxide, calcium carbonate, and silicate minerals. Laboratory exercises utilize simple experiments to give experience with methods of measurement and interpretation of results. Mr. Hall. Prerequisite: two years of chemistry or equivalent, or permission of instructor. 2 lec/1 lab/3 cr.

### 895-896. INVESTIGATIONS IN SOIL AND WATER SCIENCE

Offered in: 1) Soil-Plant Relationships, Mr. Peterson; 2) Physics of Soils; 3) Hydrology, Mr. Byers and Mr. Hall; 4) Chemistry of Water, Mr. Hall; 5) Chemistry of Soils, Mr. Harter; 6) Soil Classification, Mr. Peterson. Elective only after consultation with the instructor in charge. 1-4 cr.

### 899 (899). MASTER'S THESIS

6-10 cr.

# Mathematics

## Mathematics (51)

**Chairman:** M. Evans Munroe

**PROFESSORS:** Richard H. Balomenos, Edward H. Batho, Arthur H. Copeland, A. Robb Jacoby, Richard E. Johnson, Shan S. Kuo, M. Evans Munroe, Eric A. Nordgren, James A. Radlow, Shepley L. Ross, Robert J. Silverman

**ASSOCIATE PROFESSORS:** Homer F. Bechtell, Albert B. Bennett, Jr., William E. Bonnice, David M. Burton, Loren Meeker, Berrien Moore III, Samuel D. Shore, Donovan Van Osdol

**ASSISTANT PROFESSORS:** R. Daniel Bergeron, William Geeslin, Albert O. Shar

The mathematics department offers courses leading to three graduate degrees: Master of Science for Teachers, Master of Science, and Doctor of Philosophy.

### Master of Science for Teachers

**Admission requirements:** Completion of all requirements for secondary school teacher certification in Mathematics. Degree requirements: 1) Ten semester courses approved by the department. These will normally be taken from the courses numbered 801-829 and will usually include the six courses numbered 803-808. 2) A comprehensive examination based primarily on material in courses 803-808. It is not possible to work full time during the academic year toward the Master of Science for Teachers degree. The courses in this program are offered primarily in summer institutes.

### Master of Science

**Admission requirements:** A year of abstract and linear algebra or a year of real analysis. Preference will be given to applicants who have completed both these sequences. Degree requirements: Ten semester courses approved by the department. These must be chosen from courses numbered 701-799 or 830-899. At least six of the ten must be from the 830-899 group.

### Doctor of Philosophy

The department offers the Ph.D. under two labels: Mathematics and Mathematics-Education. These programs have a common core as follows:

**Admission requirements:** same as for the Master of Science.

**Basic Degree Requirements:** 1) all of the courses numbered 833-842; 2) proficiency in reading mathematical literature in two of three languages: French, German, and Russian; 3) experience in

teaching equivalent to at least half-time for one year; and 4) written comprehensive examination; this involves algebra, analysis (real and complex), and general topology, and should be taken after three semesters in residence.

**Additional Degree requirements for the Ph.D. in Mathematics:** 5) advanced work in a major (the field of the thesis) and a minor (usually another field of Mathematics or Mathematics-Education) with an oral examination in these two fields; and 6) thesis; new and original mathematical results will be required. Thesis work is available in Algebra, Applied Mathematics, Analysis, and Topology.

**Additional Degree requirements for the Ph.D. in Mathematics-Education:** 5) advanced work in a major (Mathematics-Education) and a minor (usually Education) with an oral examination in these two fields; 6) thesis—new and original results involving pedagogical problems in mathematics will be required.

**Courses numbered between 600 and 699 may be taken for graduate credit by non-majors only.**

#### 611. ASSEMBLER LANGUAGE PROGRAMMING

Assembler-language coding and programming techniques. Data representation, systems organization, program segmentation, linkage of control sections, manipulation of bits or bytes, micro- and macro-programming. Input/output using system macros. Interrupts. Prerequisite: Math 410 or 510. 4 cr.

#### 612. DATA STRUCTURES AND PROCESSES

Data structure programming techniques and program structure using a higher-level language such as PL/I. Linear lists, strings, arrays, trees, and graphs. Symbol tables, sorting and searching techniques. Data organization, record-oriented and stream-oriented data transmission, conversion techniques, and storage allocation. Prerequisite: Math 611. 4 cr.

#### (636). PROBABILITY AND STATISTICS

Sample spaces (discrete only), events, combinations, conditional probability, independence, distributions, expectation, statistical description, random variables, sampling, estimation, tests, and applications. Credit towards a mathematics major only in mathematics-education. 4 cr.

#### 645. APPLIED LINEAR ALGEBRA

Applied matrix theory; eigenvalue problems and their applications in mathematics, physics, and engineering; systems of linear, ordinary, differential equations. Prerequisite: Math 526-528. 4 cr.



## (646). ANALYSIS FOR APPLICATIONS

Initial-boundary-value problems of mathematical physics; Sturm-Liouville problems; series expansions by orthogonal functions; Green's functions; numerical methods. Prerequisite: Math 527-528. 4 cr.

## (647). COMPLEX ANALYSIS FOR APPLICATIONS

Complex numbers; complex integration; infinite series; contour integration; conformal mapping; Fourier and Laplace transforms; Wiener-Hopf techniques. Prerequisite: Math 528. 4 cr.

## 656. INTRODUCTION TO NUMBER THEORY

Unique factorization, linear and quadratic congruences, quadratic reciprocity law, arithmetic functions, quadratic forms, an introduction to algebraic numbers. Prerequisite: Math 531. 4 cr. (Alternate years; offered 1976-77.)

## 657. GEOMETRY I

Advanced approach to fundamental properties of Euclidean geometry. Prerequisite: Math 531. 4 cr.

## 658. GEOMETRY II

Systems of postulates of various geometries, geometric invariants, synthetic and analytic projective geometry, introduction to non-Euclidean geometry. Prerequisite: Math 531. 4 cr. (Alternate years; offered 1975-76.)

## 682. NONLINEAR DIFFERENTIAL EQUATIONS

Phase plane analysis of autonomous systems; critical points; limit cycles; periodic solutions; approximate methods for second-order nonlinear equations; stability and asymptotic behavior of solutions. Prerequisite: Math 527. 4 cr. (Alternate years; offered 1975-76.)

**A maximum of four of the following courses may be applied to the degree of Master of Science in Mathematics.**

## 710. ADVANCED PROGRAMMING SYSTEMS

Review of batch-process systems programs. Software organization; multiprogramming systems; techniques for parallel processing; multiaccessing and multiprocessing. Core management, file system design and management, and system accounting. Design of system modules and interfaces. Prerequisite: Math 611. 4 cr.

## 711. PROGRAMMING LANGUAGE AND COMPILER CONSTRUCTION

Formal definition of programming languages; specification of syntax and semantics. Global properties of algorithmic languages such as PL/I and ALGOL. Review of special purpose languages for list processing, symbol manipulation, data description and simulation; run-time representation of program and data structures; how these properties affect compilation. Prerequisite: Math 710. 4 cr.

## 735. PROBABILITY

Sample spaces (discrete and continuous); random variables; conditional probability; moments; binomial, Poisson, and normal distributions; limit theorems for sums of random variables. Prerequisite: Math 528. 4 cr.

## 736. STATISTICS

Sampling theory, estimation of parameters, testing of hypotheses, non-parametric methods. Prerequisite: Math 735. 4 cr.

## 753. NUMERICAL METHODS AND COMPUTERS I

Use of numerical analysis on computers; high-level languages, compilers; linear and non-linear equations; interpolation, quadrature, curve fitting, system simulations, optimization techniques, finite elements, computer graphics. Selected algorithms will be programmed for computer solution. Prerequisite: Math 410 or 510, and 428. 4 cr.

## 754. NUMERICAL METHODS AND COMPUTERS II

Computer solutions of ordinary and partial differential equations, finite differences vs. finite elements, eigenvalues and eigenvectors, algorithms for hidden-line graphics. Mathematical software. Prerequisite: Math 410 or 510, and 527. 4 cr.

## 761 (761). ABSTRACT ALGEBRA

Basic properties of groups, rings, fields, and their homomorphisms. Prerequisite: Math 531. 4 cr.

## 762. LINEAR ALGEBRA

Vector spaces, linear transformations, matrices, determinants, dual spaces, eigenvalues, spectral and canonical decomposition theorems. Not for credit if credit received for Math 645. Prerequisite: Math 761. 4 cr.

## 764. ADVANCED ALGEBRA

Vector spaces, modules over principal ideal domains, structure of finitely-generated modules, finite abelian groups, elementary theory of fields. Prerequisite: Math 761. 4 cr. (Alternate years; offered 1976-77.)

# Mathematics

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## 767. ONE-DIMENSIONAL REAL ANALYSIS

Theory of limits, continuity, differentiability, integrability, series, uniform convergence. Prerequisite: Math 528, 531. 4 cr.

## 768. ABSTRACT ANALYSIS

Metric spaces, function spaces, theory of uniform limits. Prerequisite: Math 767. 4 cr. (Alternate years; offered 1975-76.)

## (769). MULTIDIMENSIONAL REAL ANALYSIS

Partial derivatives, multiple integrals, line and surface integrals, Fourier series. Prerequisite: Math 767. 4 cr. (Alternate years; offered 1976-77.)

## 776. LOGIC

Formal mathematics and formal systems. Consistency, completeness, decidability. Prerequisite: Math 531. 4 cr. (Alternate years; offered 1975-76.)

## 780. THEORY OF ORDINARY DIFFERENTIAL EQUATIONS

Fundamental existence and uniqueness theorems; linear systems and higher order linear equations; Wronskian theory; classical Sturm Theorem and generalizations; boundary value problems for second order linear equations. Prerequisite: Math 767. 4 cr. (Alternate years; offered 1976-77.)

## 781. PARTIAL DIFFERENTIAL EQUATIONS

First order equations; linear second order equations; Cauchy problem; Dirichlet problem; application to physics. Prerequisite: Math 767. 4 cr. (Alternate years; offered 1975-76.)

## (784). TOPOLOGY

Connectedness, compactness, metrizability; real line and plane. Prerequisite: Math 531. 4 cr.

## (785). ALGEBRAIC METHODS IN TOPOLOGY

Topology of manifolds, topological groups, homology, knot theory. Prerequisite: Math 784. 4 cr. (Alternate years; offered 1975-76.)

## (786). CALCULUS ON MANIFOLDS

Differentiable manifolds; differential forms; exterior and Grassman algebras; integration of differential forms; Stokes theorem; closed and exact differential forms. Not for credit if credit received for Math 769. Prerequisite: Math 762 and 767. 4 cr. (Alternate years; offered 1976-77.)

## (787). DIFFERENTIAL GEOMETRY

Introduction to Lie groups and frame bundles; differential invariants of surfaces and curves; local theory of surfaces. Prerequisite: Math 786. 4 cr. (Alternate years; offered 1976-77.)

## 788. COMPLEX ANALYSIS

Complex functions, sequences, limits, differentiability and Cauchy-Riemann equations, elementary functions, Cauchy's theorem and formula, Taylor's and Laurent's series, residues, conformal mapping. Not for credit if credit received for Math 647. Prerequisite: Math 767. 4 cr.

**The following courses may be applied to the degree of Master of Science for Teachers in Mathematics and to no other graduate degree in Mathematics.**

## 801-802. MATHEMATICS AND COMPUTING FOR TEACHERS

Linear equations, linear inequalities, computer arithmetic and programming, never-ending algorithms, algorithms for areas, computer-oriented numerical methods. The course is designed to introduce methods of computation using a computer in the context of a mathematics course. BASIC and FORTRAN programming languages will be taught. 6 cr.

## 803-804. HIGHER ALGEBRA FOR TEACHERS

The integers, integral domains, and topics from number theory; equivalent relations and congruences; real numbers, complex numbers, and fields, polynomials; group theory; elements of matrix theory; vectors and vector spaces; rings; Boolean algebra. 3 cr.

## 805-806. HIGHER GEOMETRY FOR TEACHERS

Systems of postulates of various geometries; geometric invariants; synthetic and analytic projective geometry; an introduction to non-Euclidean geometry; and topology. 3 cr.

## 807-808. HIGHER ANALYSIS FOR TEACHERS

The real number system; variables, functions and limits; elements of set theory; numerical sequences and series; continuity; the derivative and the Riemann integral maxima and minima. 3 cr.

## 809. PROBABILITY AND STATISTICS FOR TEACHERS

Permutations and combinations; finite sample spaces; random variables; binomial distributions; statistical applications. 3 cr.

## 810. MATHEMATICS EDUCATION

1) Current Developments and Issues in Mathematics Education. A workshop focused on selected mathematics curriculum development projects such as SMSG, UICSM, the Madison Project, SIV-CSMP, the Nuffield Project, and issues such as those represented by the Cambridge conference, the role of mathematics laboratories, the integration of science and mathematics courses, computer-assisted instruction, the role of computers. 2) Teaching of Mathematics. A seminar focused on the introduction of mathematical ideas from the subject-matter courses (801-802, 805-806, 807-808, 826, 829) into the school curriculum with particular emphasis placed on teaching in the secondary school. 1-4 cr.

## 811. COMPUTERS AND THEIR USES

Computing machines and modern numerical methods. Each student will have an opportunity to make use of the University computer. 3 cr.

## 814. TOPOLOGY FOR TEACHERS

Fundamental concepts of elementary topology; network and map problems; sets, spaces, and transformations. 3 cr.

## 816. THEORY OF NUMBERS FOR TEACHERS

Divisibility and primes; congruences; quadratic reciprocity; number theoretic functions; Diophantine equations; Farey fractions; algebraic numbers. 3 cr.

## 817. THEORY OF SETS AND ELEMENTARY LOGIC

An introduction. 3 cr.

## 819. THE REAL NUMBER SYSTEM

A postulational approach. Brief discussion of algebraic structures. Introduction to the sequences, limits, and continuity. 3 cr.

## 820. HISTORY OF MATHEMATICS

A problem-study approach to mathematical problems and solutions from the period of Greek mathematics until the 1950s will be used to present the history of mathematics. 3 cr.

## 821. A MODERN APPROACH TO GEOMETRY

The foundations and development of Euclidean geometry, with emphasis on the recent School Mathematics Study Group's recommendations in the field of high school geometry. 3 cr.

## 825. INTERNSHIP

Experience under the direction of a master teacher in teaching university level mathematics to superior high school students. This work will be done in the Advanced Studies Program at St. Paul's School, Concord, New Hampshire. 6 cr.

## 826. SELECTED TOPICS IN ALGEBRA

Topics selected to supplement the teacher's previous training in algebra, chosen from among the following: linear algebra, vector spaces, groups, rings and ideals, and fields. 3 cr.

## 827. SELECTED TOPICS IN GEOMETRY

Topics selected to supplement the teacher's previous training in geometry, chosen from among the following: analytic projective geometry, non-Euclidean geometry, transformation theory, elementary metric differential geometry, topology. 3 cr.

## 828. SELECTED TOPICS IN ANALYSIS

Topics selected to supplement the teacher's previous training in analysis, chosen from among the following: sequences and series of real functions, Riemann integration, partial differentiation, complex functions, differential equations. 3 cr.

## 829. DIRECTED READING

A directed reading project on a selected topic in mathematics chosen to supplement the teacher's previous institute courses. A written examination will be required. 3 cr.

The following are the basic courses for both the Master of Science and Doctor of Philosophy degrees in Mathematics.

## 833-844. ALGEBRA

Groups; rings, modules; fields; linear algebra. 3 cr.

## 835. MEASURE AND INTEGRATION

Outer measures and measures; Lebesgue integrals; convergence theorems. 3 cr.

## 836. FUNCTIONAL ANALYSIS

Banach spaces; representation of linear functionals; weak and weak\*-topologies. 3 cr.

## 837-838. COMPLEX ANALYSIS

Complex variables and functions; analytic functions; complex integration; series and products; conformal mapping; analytic continuation and Riemann surfaces. 3 cr.

# Mechanical Engineering

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## 839-840. GENERAL TOPOLOGY

Topological spaces; nets and filters; product and quotient spaces; embedding and metrization; compact spaces; uniform spaces; homotopy and fundamental group; covering spaces and fibrations. 3 cr.

## 841-842. ALGEBRAIC TOPOLOGY

Chain complexes; homology of simplicial complexes, singular homology and cohomology; axiomatic homology; cup and cap products; topological manifolds; sheaves. 3 cr.

The following are advanced courses primarily for Doctor of Philosophy candidates, though they may be elected by qualified Master of Science candidates. In each of these the content will vary from year to year. Thus, with permission of the instructor, each of these courses may be taken more than once for credit, even concurrently. Normally, the content will be chosen from among the topics listed.

## 861-862. TOPICS IN ALGEBRA

Algebraic number theory; algebraic geometry; ring theory; theory of modules; group theory; non-associative algebras. 3 cr.

## 863, 864. TOPICS IN ANALYSIS

Measure theory; calculus of variations; integral equations; boundary-value problems; orthogonal series; theory of approximation; analytic number theory; Riemann surfaces. 3 cr.

## 865, 866. TOPICS IN TOPOLOGY

Algebraic topology; theory of sheaves; dimension theory; Riemann surfaces; homotopy theory. 3 cr.

## 867, 868. TOPICS IN GEOMETRY

Convexity; projective geometry; differential geometry; tensor analysis. 3 cr.

## 869, 870. TOPICS IN FUNCTIONAL ANALYSIS

Rings of functions; linear topological spaces; topological algebras; Hilbert spaces, rings of operators; topological groups; Lie groups; harmonic analysis. 3 cr.

## 871, 872. TOPICS IN DIFFERENTIAL EQUATIONS

Boundary value problems; asymptotic behavior and stability theory; nonlinear equations; dynamic systems; classical theory of partial differential equations; functional analysis and partial differential equations. 3 cr.

## 873, 874. TOPICS IN APPLIED MATHEMATICS

Linear and dynamic programming; differential equations; special functions. 3 cr.

## 875, 876. TOPICS IN PROBABILITY AND STATISTICS

Stochastic processes. 3 cr.

## 877, 878. TOPICS IN LOGIC AND FOUNDATIONS

Deductive systems; set theories; recursive functions; undecidability; model theory. 3 cr.

## 879, 880. TOPICS IN MATHEMATICS EDUCATION

A detailed analysis of selected problems and issues of current concern in the area of mathematics education, especially the nature and role of mathematics, current curricula, teaching methods, evaluation, problem solving, research design, and research results. 3 cr.

## 898. READING COURSES

Offered in the following areas: (a) Algebra, (b) Analysis, (c) Topology, (d) Geometry, (e) Functional Analysis, (f) Differential Equations, (g) Applied Mathematics, (h) Probability and Statistics, (i) Mathematics Education. 3-6 cr.

## 999. DOCTOR OF PHILOSOPHY THESIS

# Mechanical Engineering (52)

**Chairman:** William Mosberg

**PROFESSORS:** Victor D. Azzi, Robert W. Corell, Godfrey H. Savage, Charles K. Taft, Asim Yildiz

**ASSOCIATE PROFESSORS:** E. Eugene Allmendinger, Wayne M. Beasley, Frederick G. Hochgraf, David E. Limbert, William Mosberg, Russell L. Valentine, John A. Wilson

**ASSISTANT PROFESSOR:** Barbaros Celikkol

**VISITING PROFESSOR:** Musa Yildiz

The Mechanical Engineering Department offers programs of study, from the viewpoint both of the engineering sciences and of engineering design, in mechanics, materials science, automatic control, and the thermal sciences, leading to the degree of Master of Science in Mechanical Engineering. The programs provide the background required for careers in research, engineering design, or teaching, or for further graduate study.

To be admitted to graduate study in Mechanical Engineering, a student should have completed work equivalent to that required at

the University of New Hampshire for a Bachelor of Science degree in his field.

A candidate for the degree of Master of Science shall satisfy the requirements of either a thesis plan or a project plan. The thesis plan requires 24 semester hours of course work in addition to Mechanical Engineering 899, Master's Thesis; the project plan requires 30 semester hours of course work in addition to Mechanical Engineering 892, Master's Project. Individuals with special qualifications may petition the department to be excused from the project requirement. An oral examination covering the candidate's graduate work will be given whether or not a thesis is presented.

Students interested in graduate study beyond the Master's degree should refer to the interdepartmental Engineering Ph.D. Program which includes the following areas of specialization: engineering system design, signal processing, theoretical and applied mechanics, and transport phenomena. For details refer to the section entitled Engineering Ph.D. Program on page 70.

Students completing degree requirements through the Division of Continuing Education must be admitted to the Graduate School and have their programs approved by the department.

No more than two graduate courses taken prior to admission to the Graduate School may be applied to the master's degree. Courses numbered between 600 and 699 may be taken for graduate credit by non-majors only.

Permission of the instructor and consent of the adviser are required for enrollment in all Mechanical Engineering graduate courses.

## **701. MACROSCOPIC THERMODYNAMICS**

Thermodynamic principles using an analytic, postulational approach and Legendre transformations to obtain thermodynamic potentials. 4 cr.

## **702. STATISTICAL THERMODYNAMICS**

Macroscopic thermodynamic principles developed by means of microscopic analysis. Prerequisite: M.E. 503. 4 cr.

## **703. HEAT TRANSFER**

Analysis of phenomena; steady-state and transient conduction, radiation, and convection; engineering applications. Prerequisite: M.E. 508 or taken concurrently. 4 cr.

## **704. EXPERIMENTAL HEAT TRANSFER**

Methods in the study and solution of problems, including a critical comparison with analytical and other methods. Prerequisite: M.E. 703. 4 cr.

## **707. ANALYTICAL FLUID DYNAMICS**

Potential flow, development of the Navier-Stokes equations, turbulence and boundary-layer theory. Prerequisite: M.E. 508. 4 cr.

## **708. GAS DYNAMICS**

Basic equations of motion of one-dimensional, subsonic and supersonic flows of compressible, ideal fluids. Wave phenomena. Rankine-Hugoniot relations. Linear approach to two-dimensional flow problems. Prerequisite: M.E. 508. 4 cr.

## **715. INTERNAL COMBUSTION ENGINES**

Basic and engineering science applied to spark and compression-ignition engines; design, management, and reporting of experimental studies. Prerequisite: M.E. 503. 4 cr.

## **716. PROPULSION SYSTEMS**

Basic engineering sciences applied to the engineering problems of propulsion systems. Prerequisite: M.E. 508. 4 cr.

## **717. CYROGENICS**

Phenomena and processes with very low temperatures. Basic engineering sciences applied to problems of low temperature refrigeration, liquefaction, separation, and storage; transport of cryogenic fluids; measurement systems; vacuum technology. Prerequisite: M.E. 503. 4 cr.

## **723. ADVANCED DYNAMICS**

Classical dynamics oriented to contemporary engineering applications. Review of particle dynamics. Hamilton's principle and the Lagrange equations. Kinematics and dynamics of rigid bodies, gyroscopic effects in machinery and space structures. 4 cr.

## **724. INTRODUCTION TO VIBRATIONS**

Discrete vibrating systems. Linear system concepts; single-degree-of-freedom system with general excitation. Matrix theory and eigenvalue problems. Many degrees of freedom, normal mode theory for free and forced vibration. Numerical methods; introduction to continuous systems; applications to structural and mechanical systems. 4 cr.

## **726. EXPERIMENTAL MECHANICS**

Experimental methods and theoretical bases applied to measurement of stress, strain, and motion. Transmitted and scattered-light photoelasticity; strain gage applications; brittle coating and grid techniques; dynamic measurements, and associated instrumentation. 4 cr.

# Mechanical Engineering

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## 727. ADVANCED MECHANICS OF SOLIDS

Beams on elastic foundation, curved bars, inelastic behavior, instability, introduction to thin plates and shells, introduction to elasticity, energy methods, and numerical methods. 4 cr.

## 730. MECHANICAL BEHAVIOR OF MATERIALS

Elastic and inelastic behavior of materials in terms of micro- and macromechanics. Stress, strain, and constitutive relations related to recent developments in dislocation theory and other phenomena on the atomic scale and to continuum mechanics on the macroscopic scale. Elasticity, plasticity, viscoelasticity, creep, fracture, and damping. Anisotropic and heterogeneous materials. 4 cr.

## 737. OCEAN MECHANICS I

Ocean as a continuous medium, its mechanical and thermodynamic properties. Shallow and deep ocean modeling for the investigation of gravity and sound waves. Ocean subbottom and its soil mechanical and sound propagation properties. Instrumentation, rudimentary data collecting and processing procedures, and computer usage. Prerequisite: M.E. 508 and 523, 524; Math 527, 528. 4 cr.

## 738. OCEAN MECHANICS II

Ocean dynamical laws are generalized to include temperature and salinity variations in the water column. Conservation laws with generalized equation of state. Air-sea interaction, energy transport phenomena, reflection from different coastal geometry, harbour resonances, internal currents. Sound reflection from subbottom, sound probing techniques to determine subbottom properties by ray theory, and generalization of subbottom soil from an elastic to a viscoelastic medium. Prerequisite: M.E. 737; M.E. 781 is desirable but not required. 4 cr.

## 741. CONTROL OF PHYSICAL SYSTEMS

Mathematical modeling of hydraulic, pneumatic, and fluidic control elements and control systems. Analysis of systems using gases or liquids as the working fluid. Methods for the synthesis of the parameters of the control elements used in automatic control systems and design of these systems. 4 cr.

## 751. NAVAL ARCHITECTURE IN OCEAN ENGINEERING

Architectural principles related to surface and submerged vehicles. Hydrostatic characteristics, fundamentals of powering, and rules and regulations. Prerequisite: M.E. 508 or permission of instructor. 4 cr.

## 752. SUBMERSIBLE VEHICLE SYSTEMS DESIGN

Historical perspective, environmental factors, hydromechanics and structural principles, materials, intra-vehicle systems, extra-vehicle systems, operating considerations, pre-design and design procedures. Conceptual and basic preliminary designs of selected submersible vehicles are prepared by student teams. 4 cr.

## 757. COASTAL ENGINEERING AND PROCESSES

Water waves and their effects. Equations for surface waves and laboratory tank demonstration of wave trains, beat waves, and wave spectra. Estuarial and coastal processes including wave refraction and long shore transport of sediments simulated by computer models. Effects of structures on waves and functional design of structures including towers, breakwaters, and ocean outfall. 4 cr.

## 760. PHYSICAL METALLURGY

Introduction to the electron theory of materials; entropy and free-energy concepts of the solid state; diffusion in metals; nature and kinetics of selected solid state reactions. 4 cr.

## 761. X-RAY DIFFRACTION

The physics of x-ray diffraction, the reciprocal lattice, lattice parameter determinations, space group identification, phase identification, characterization of preferred orientation. 3lec/1lab/4 cr.

## 763. MICROSTRUCTURE OF SOLIDS

Basic concepts and measurements; statistically exact expressions for points, lines, surfaces, and volumes; random, partially-oriented and oriented structures; particle and grain characteristics and distributions; projected images and shape specification. 4 cr.

## 766. PHYSICAL CERAMICS

Characteristics of crystalline and non-crystalline ceramic solids; defect structures; diffusion in ceramic materials; nucleation, crystal growth, and solid-state reactions; kinetics of grain growth, sintering, and vitrification. 4 cr.

## 781. MATHEMATICAL METHODS IN ENGINEERING SCIENCE—I

Solution of discrete and continuous systems. Review of calculus, linear algebra, complex numbers, Fourier series, differential and partial differential equations with examples from acoustics, vibration theory, hydrodynamics, elasticity, solid mechanics, transport theory, and particle mechanics. 4 cr.

## **793 a-d, 794 a-d. SPECIAL TOPICS IN ENGINEERING**

Course numbers refer to topics in a) thermodynamics, b) mechanics, c) engineering design, and d) materials, respectively. Content of these courses may vary from year to year. 2-4 cr.

## **795 a-d, 796 a-d. INDEPENDENT STUDY**

Course numbers refer to topics in a) thermal science, b) solid mechanics, c) engineering design, and d) materials, respectively. 2-4 cr.

## **801. IRREVERSIBLE THERMODYNAMICS**

Non-equilibrium thermodynamics from the viewpoint of fluctuation theory. The Onsager reciprocal relations. Prerequisite: Mechanical Engineering 701. 4 cr.

## **803. CONDUCTION HEAT TRANSFER**

Heat conduction equation temperature fields and heat flux vector; analytical solution of the conduction equation in several variables; initial and boundary value problems; numerical methods of solution. 4 cr.

## **804. RADIATION HEAT TRANSFER**

The fundamentals of radiant heat transfer. Development and solution of the wave equation for electromagnetic radiation. Analysis of Planck's law of radiation and earlier theories. Methods of solution of radiant interchange in real systems with and without absorbing media. 4 cr.

## **806. CONVECTION HEAT TRANSFER**

An analytical study of heat transfer to laminar and turbulent boundary layers of compressible and incompressible fluids. Basic differential equations governing the heat transfer are derived and analytical solutions are obtained where possible and checked with experimental results. 4 cr.

## **807. COMPRESSIBLE FLUID FLOW**

General equations of motion for real and ideal compressible fluid flow, including boundary layer equations, methods of solution. Prerequisite: Mechanical Engineering 707 or 708. 4 cr.

## **808. THEORETICAL AERO/HYDRO-MECHANICS**

The Mathematical development of the equations of frictionless fluid flow, using both tensor notation and various coordinate systems. Conformal mapping; Blasius theorem; Joukowski hypothesis; flow around airfoils. Schwarz Christoffel theorem and vortex motion. 4 cr.

## **822. CONTINUUM MECHANICS**

Conservation laws for gases, liquids, and solids in a continuum are developed starting from Liouville and Boltzmann equations. Passage from a discrete system to a continuum is discussed. Constitutive equations for viscoelastic, thermoelastic and non-linear gas, liquid, and elastic fields. General discussion of rheological behavior. Causality conditions for continuum fields. Examples for solids, liquids, and gases, and biomechanics. Introduction to phenomenological Lagrangian theories. 4 cr.

## **824. VIBRATIONS OF CONTINUOUS MEDIA**

Classical and numerical methods are employed to study the vibration of continuous elements and structures. Topics considered are axial and torsional vibration of rods, transverse vibration of beams and thin plates, wave propagation, and vibration of simple structures. 4 cr.

## **826. THEORY OF ELASTICITY**

The analysis of stress and deformation in elastic solids; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; elastodynamic fields; inhomogenous, anisotropic, wave equations; wave propagation, and stress concentration problems; generalizations to thermoelasticity and viscoelastic fields. Complex variable techniques will be used. 4 cr.

## **827. THEORY OF PLASTICITY**

Analysis of stress and deformation in inelastic solids; general development of stress invariants, variational principles, constitutive relations, and yield and loading functions. Special emphasis on ideal plasticity, strain-hardening, creep, limit analysis, and limit design. 4 cr.

## **829. THEORY OF PLATES AND SHELLS**

Theory of elasticity developed for plates and shells; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; stress and strain relations in curvilinear coordinates; thin and thick plate and shell theories; vibration of spherical, cylindrical, and conical shells and plates. 4 cr.

## **838. THEORETICAL ACOUSTICS**

Fundamentals are presented with emphasis on theory and applications in underwater acoustics and in the acoustic determination of dynamic material properties. Topics include: a review of vibration theory; derivation of nonlinear acoustic field equations; linearization; Green's function techniques and solution of boundary value problems; scattering, reflection theories of

# Microbiology

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boundary roughness; development of ray theory (geometric optics) from field equations; and Eikonal approximations. 4 cr.

## 842. DISCONTINUOUS CONTROL

The analysis and synthesis of feedback control systems operating on quantized information; compensation and performance improvement methods which use the quantized nature of the information are also developed. 4 cr.

## 844. NONLINEAR CONTROL SYSTEMS

Analysis and design of nonlinear control systems from the classical and modern viewpoints are discussed. Topics include: Liapunov's stability theory; phase space methods; linearization techniques; simulation; frequency response methods; generalized describing functions; transient analysis utilizing functional analysis; and decoupling of multivariable systems. Prerequisite: Electrical Engineering 851. 4 cr.

## 865. CONDUCTION PROPERTIES IN SOLIDS

Topics in metal and semiconductor physics. Quantum theory, electron energy states, scattering processes, band theory, electron and hole conduction, and the P-N junction. 4 cr.

## 882. MATHEMATICAL METHODS IN ENGINEERING SCIENCE II

This course is a continuation of Mechanical Engineering 781 which is a prerequisite. Topics treated include complex variable techniques, integral transform techniques for the solution of differential and partial differential equations, Green's functions, Weiner-Hopf techniques, variational techniques. Stochastic problems with application to random vibration, statistical control theory, turbulence, heat conduction and fluctuation phenomena in solids, transport theory, gases, and liquids. Topics may vary from year to year. 4 cr.

## 883. TENSOR ANALYSIS AND DIFFERENTIAL GEOMETRY

Mathematical groundwork for applied group theory, transformation groups, affine groups and affine geometry. Coordinate transformations and point transformations. Affinors, tensors, and their algebraic properties. Invariant differential operators. Lie derivative, holonomic and anholonomic coordinate systems. Curvature tensor, Bianchi identity, tensor densities. Green's theorem, Green's functions, potential functions. Pfaff's problem. 4 cr.

## 890 a-d and 891 a-d. SPECIAL TOPICS IN ENGINEERING

Course numbers refer to topics in a) thermodynamics, b) mechanics, c) engineering design, and d) materials. Content of these courses may vary from year to year. 2-4 cr.

## 892. MECHANICAL ENGINEERING MASTER'S PROJECT

The student works with a faculty member during one or two semesters on a well defined research and/or original design problem. A written report and seminar are presented. 1-4 cr.

## 895 a-d and 896 a-d. GRADUATE INDEPENDENT STUDY

Investigation of graduate level problems or areas germane to mechanical engineering. 1-4 cr.

## 899. MASTER'S THESIS

6-10 cr.

Students may also enroll in Technology (45) 601.

## 601. STATISTICAL METHODS IN ENGINEERING AND PHYSICAL SCIENCE

Methods of organizing data and statistical techniques for data analysis, as applied to problems in engineering and physical science. Elementary probability theory, probability distribution; tests of significance, correlation, and regression analysis. Design of experiments; completely randomized blocks; factorials, fractional factorials; process optimization. Introduction to quality control; construction and analysis of control charts for variables and attributes; statistical aspects of tolerance. 4 cr.

# Microbiology (70)

**Chairman:** Theodore G. Metcalf

**PROFESSORS:** William R. Chesbro, Galen E. Jones, Theodore G. Metcalf, Lawrence W. Slanetz

**ASSISTANT PROFESSORS:** Thomas G. Pistole, Robert M. Zsigray

Students admitted to graduate study in Microbiology are expected to have had adequate preparation in the biological and physical sciences and in the basic courses in Microbiology.

The candidate for the Master of Science degree will be required to complete a thesis. Candidates for the Doctor of Philosophy degree must demonstrate proficiency in reading microbiological literature in one foreign language, usually French or German; must teach at least one semester, or have had equivalent experience; must demonstrate to the doctoral committee a broad, basic knowledge of the field of Microbiology; and must complete a dissertation embodying the results of original research in Microbiology.

Departmental research activities emphasize immunologic aspects of bacterial host-parasite interactions, analysis of microbial structures at cellular and molecular levels, bacterial and bacterio-



phage genetics, studies of viruses pathogenic for man and animals, cell culture phenomena, public health and sanitary aspects of microbiology and virology, and marine microbiology.

## **701. ADVANCED MICROBIOLOGY**

Growth, nutrition, and metabolism of microorganisms, cell structure and localization of function; genetic and non-genetic regulation of metabolism; classification and taxonomy. Prerequisite: Micro. 503 and Biochemistry 656 or equivalent. 2 lec/1 lab/4 cr.

## **702. PATHOGENIC MICROBIOLOGY**

The morphological, cultural, biochemical, serological, and pathogenic characteristics of microorganisms causing human and animal diseases. Prerequisite: Micro. 503. 2 lec/2 lab/4 cr.

## **705. IMMUNOLOGY AND SEROLOGY**

Defensive elements possessed by man and animals protective against infectious microorganisms. Principles of serological techniques for recognition and identification of biological materials including microorganisms. Preparation of vaccines and production of antisera in animals. Prerequisite: Micro. 702. 2 lec/2 lab/4 cr.

## **706. VIROLOGY**

Viruses, including animal and bacterial, and rickettsiae; interaction of viruses and host cells; technics for propagation and recognition including immunologic methods; applications to infectious disease, the environment, and cancer. Prerequisite: Micro. 702. 1 lec/3 lab/4 cr.

## **707. MARINE MICROBIOLOGY**

Characterization of microorganisms in the sea including taxonomy, physiology, and ecology; sampling, enumeration, distribution; and effects of marine environment upon microbial populations. Prerequisite: Micro. 503 and organic chemistry. 2 lec/1 lab/4 cr.

## **708. MICROBIAL BIOGEOCHEMISTRY**

Geochemical processes influenced by biochemical processes catalyzed by marine and terrestrial microorganisms; transformations of carbon, nitrogen, and other elements. Petroleum microbiology, natural gas production, sulfur formation, ferromanganese nodules, corrosion, and fossil microorganisms. Prerequisite: Micro. 503 and organic chemistry. 2 lec/1 lab/4 cr.

## **795, 796. PROBLEMS IN MICROBIOLOGY**

Prerequisite: permission of department chairman and staff. Cr. to be arranged.

## **800. SYSTEMATIC MICROBIOLOGY**

Procedures, methods for classification of microorganisms; review of systems of classification. Prerequisite: one year of microbiology. 2 lec/1 lab/4 cr.

## **802. MICROBIAL PHYSIOLOGY**

Means by which microorganisms survive: nutritional, chemical, physical factors; metabolism and its regulation; generation of cell ultrastructure; ecological interactions. Prerequisite: Micro. 503, General Biochemistry (not to be taken concurrently). 2 lec/1 lab/4 cr.

## **803. MICROBIAL CYTOLOGY**

Fine structure of bacteria and related microorganisms (Prokaryotic Protists). Current techniques for demonstration and isolation of cell structures, inclusions and chromatin bodies. Prerequisite: Microbiology 701. 2 lec/1 lab/4 cr.

## **804. MICROBIAL GENETICS**

Expression, regulation, recombination and transmission of genetic information in procaryotic and eucaryotic microorganisms. Consideration of chromosomal and extrachromosomal inheritance. Prerequisite: Micro. 503 and permission of instructor. 2 lec/1 lab/4 cr.

## **851. CELL CULTURE**

Theory, principles fundamental to culture of cells in vitro. Introduction to techniques of preparation, maintenance of animal, plant, insect, fish cell cultures. Application of cell culture to contemporary research in biological sciences. Prerequisite: Microbiology 503 and permission of instructor. Also offered as Animal Science 851. 2 lec/1 lab/4 cr.

## **897-898. MICROBIOLOGY SEMINAR**

Reports, discussions, microbiological literature, and current developments in microbiology. Prerequisite: permission of instructor. 1 cr.

## **899. MASTER'S THESIS**

6-10 cr.

## **999. DOCTORAL RESEARCH**

## Music (71) (72)

**Chairman:** Paul Verrette

**PROFESSORS:** Donald Steele, John Wicks

**ASSOCIATE PROFESSORS:** Mark DeVoto, Alan Grishman, Cleveland Howard, Keith Polk, Mary Rasmussen, John Rogers, John Whitlock

**ASSISTANT PROFESSORS:** Stanley Hettinger, Niel Sir, Paul Verrette, Henry Wing, Jr.

The Department of Music offers programs leading to the degrees of Master of Art in Music and Master of Science in Music Education.

### Master of Arts in Music

At the University of New Hampshire the degree of Master of Arts in Music is designed for students interested in broadening their knowledge of the history of music, but at the same time it offers ample opportunity to pursue more specialized studies in music theory, performance, performance-practice, or music literature. The following courses are required: Music 855, 856, 857, 858, 891, 893 or 894, or their approved equivalents. The student may elect courses in the 700 series in music or the 600, 700, and 800 series in other departments with the permission of the student's adviser. The department recommends that a student allow more than two semesters for completion of the program.

The department requires a Bachelor of Arts degree in Music or its equivalent from an accredited institution for admission to this program. Placement examinations in theory, music history, and aural identification are required of all applicants and are taken in the semester or summer preceding entrance into the graduate program. Students not meeting standards in the placement examinations will be required to make up their deficiencies.

A reading knowledge of both German and French is strongly recommended before entering the program; a German reading examination will be administered by the department. On recommendation of the graduate adviser, this requirement may be waived for students who do not plan further study beyond the M.A. degree. Oral examinations are required of all Master of Arts degree candidates.

### Master of Science in Music Education

The goal of the Master of Science in Music Education degree is to develop a broad knowledge at the graduate level in the fields of music education, performance, history, theory, and independent study. Each candidate will be required to complete one of the following: a professional paper; a field study in music education; a satisfactory recital appearance; a major composition, orchestration, or band arrangement; or the preparation and conducting of a major work in public performance for band, orchestra, or chorus. The following courses are required: Music 855; 893 or 894; Music Education 796; 883 or 884. Also required are 2 courses in the Department of Education from courses such as the following: Education 820, 827, 841, 853, 858, 861, 865, 883, 884, 886, and the 700 courses. Vocal or instrumental study at the 800 level is required to a minimum of 4 credits. A maximum of 9 credits is allowed if the graduate recital option is elected. Sufficient electives must be taken to total 30 credits.

Admission to this program depends upon a bachelor's degree in Music Education or its equivalent from an accredited institution. Placement examinations in theory, music history, and aural identification will be required of all applicants. The student must take these examinations in the semester or summer preceding entrance into the graduate program. Students not meeting standards in the placement examinations will be required to make up deficiencies.

### Music (71)

#### 701. MUSIC OF THE MEDIEVAL PERIOD

The nature of the beginnings of polyphony. The pre-eminent influence of the church in the 13th century and the rising secular movement in the 14th. Music as a dominant force in the political and social life of the Middle Ages. 4 cr.

#### 703. MUSIC OF THE RENAISSANCE

Works of 15th and 16th century composers from Dunstable to Palestrina. 4 cr.

#### 705. MUSIC OF THE BAROQUE

Music of Europe from de Rore to Bach. 4 cr.

#### 707. MUSIC OF THE CLASSICAL PERIOD

The growth of musical styles and forms from early classical, baroque-influenced composers through the high classicism of Haydn and Mozart, to the budding romanticism of the young Beethoven. Representative symphonies, concerti, and operas will be heard. 4 cr.

## 709. MUSIC OF THE ROMANTIC PERIOD

The symphonies, concerti, chamber music, and keyboard works of Beethoven, Berlioz, Schubert, Mendelssohn, Schumann, Brahms, Franck, Chopin, and Liszt. Romantic elements contained in the development of harmony, orchestration, sonority, expressive content. The rise of the short piano piece, the German art song, the symphonic poem, nationalism in music. 4 cr.

## 711. MUSIC OF THE 20th CENTURY

Contemporary music including its literature, its trends, and an analysis of techniques, styles, forms, and expression. 4 cr.

## 721. THE LIFE AND WORKS OF BEETHOVEN

The piano sonatas, the concerti, symphonies, and string quartets. 4 cr.

## 732. THE ART SONG

The history and literature of the solo song with piano accompaniment. Survey of national styles of the 19th and 20th centuries and deeper study of the central core of the art song—the German Lied. 4 cr.

## 733. SURVEY OF OPERA

Representative masterpieces of this art form through listening, reading, and discussion. 4 cr.

## 735. SURVEY OF PIANOFORTE LITERATURE

Keyboard literature from Bach to the present. Discussion and performance of the works of Bach; the sonatas and concerti of Haydn, Mozart, Beethoven, Schubert, the romantic composers, and of contemporary writers. 4 cr.

## 754 (754). COLLEGIUM MUSICUM

Instrumentalists and singers perform small ensemble music from all periods, with emphasis on Renaissance and Baroque music. Prerequisite: permission of instructor. 1 cr.

## 755 (755). PERFORMANCE STUDIES IN MEDIEVAL MUSIC

Performance of vocal, vocal-instrumental, and instrumental ensemble, circa 1100 to 1450; rhythm, *musica ficta*, notation, melodic ornamentation, improvised polyphony, and the clear projection of a polyphonic texture. Evaluation of the writings of selected medieval theorists and modern scholars; practical exercises in transcription; and performance on reconstructions of medieval instruments, especially the organ, harp, psaltery, rebec, vielle, and recorder. 2 or 4 cr.

## 756 (756). PERFORMANCE STUDIES IN RENAISSANCE MUSIC

Problems of musical performance, circa 1450 to 1600, via the small vocal, vocal-instrumental, and instrumental ensemble; rhythm and tempo, *musica ficta*, text underlay, articulation, diminution, tablature notation, and effective distribution of voices and instruments. Survey of performance manuals, iconographical sources, and current research; development of editing technique through the preparation of transcriptions; and an opportunity to perform on the organ, harpsichord, lute, viols, recorders, cornets, and trombones. 2 or 4 cr.

## 757 (757). PERFORMANCE STUDIES IN BAROQUE MUSIC

Performance practices in solo keyboard works, sonatas a2 and a3 and solo cantatas, circa 1640 to 1750, concentrating on ornamentation, realization of figured basses, improvisation, articulation, rhythm, keyboard registration, and the influence of the construction of baroque musical instruments (including the organ) on sonority and technique. Course work includes an examination of manuscripts (on microfilm), prints, treatises, and iconographical sources and the editing and realization of selected works for recital performance. 2 or 4 cr.

## 758 (758). PERFORMANCE STUDIES IN CLASSICAL MUSIC

Performance of keyboard music and instrumental chamber music, circa 1760 to 1815, emphasizing the relationship between structure and interpretation, late 18th century conventions of ornamentation and articulation, a survey of tutors and relevant theoretical writing, and a critique of currently published editions and editing techniques. 2 or 4 cr.

## 759 (759). PERFORMANCE STUDIES IN 19th CENTURY MUSIC

Performing and coaching Lieder, piano music, and instrumental chamber music from Schubert through Debussy; effective ensemble, traditions of interpretation, and the influence of structure on performance. 2 or 4 cr.

## 760 (760). PERFORMANCE STUDIES IN 20th CENTURY MUSIC

Small instrumental or vocal-instrumental ensembles, with intensive work in structural analysis, rhythmic ensemble coordination, dynamic and articulation control, new instrumental techniques, notation, improvisation, and the interaction between jazz and European styles. 2 or 4 cr.

# Music

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## **771-772. COUNTERPOINT**

Contrapuntal techniques of tonal music. Melodic construction and dissonance treatment through work in species counterpoint and studies in harmonic elaboration and prolongation. Analysis of selected compositions emphasizes the connection between fundamental contrapuntal techniques and the voice-leading of composition. Prerequisite: Mu. 572 or permission of instructor. 2 cr.

## **773. CANON AND FUGUE**

A continuation of Mu. 772. The procedures of polyphonic tonal textures through the analysis and composition of canons and fugues. Prerequisite: Mu. 772 or permission of instructor. 2 cr.

## **775-776. COMPOSITION**

Construction of phrases, periods, and short compositions following classical models. Problems of text-setting. Prerequisite: Mu. 572 or permission of instructor. 3 cr.

## **777-778. ADVANCED COMPOSITION**

A continuation of Mu. 776. Individual compositional projects. Prerequisite: Mu. 776 and permission of instructor. 3 cr.

## **779. ORCHESTRATION**

The characteristics of band and orchestral instruments both individually and in small (homogeneous) and large (mixed) groupings. Students study scores, write arrangements, and have arrangements performed if at all possible. Some aspects of vocal writing. Prerequisite: Mu. 572 or permission of instructor. 4 cr.

## **781. FORM AND ANALYSIS**

Formal and textural elements; concepts and examples. Thorough analysis of smaller and larger masterworks from the standpoint of harmony, counterpoint, structural line, and formal articulation. Prerequisite: Mu. 572 or permission of instructor. 4 cr.

## **785. ELECTRONIC SOUND SYNTHESIS**

Part I: "traditional" or "analog" electronic sound synthesis; work with the Buchla Synthesizer in the electronic music studio. Part II: 1) elementary programming in FORTRAN, 2) the logic of computer sound synthesis, and 3) programming in MUSIC4BF. Students will have the opportunity to run programs on the IBM 360/50 computer and its associated 12-bit digital/analog converter. Part III: supervised independent study in one or both of the above areas. Prerequisite: permission of instructor. 4 cr.

## **795. SPECIAL STUDIES IN MUSIC EDUCATION**

Allows upper-level students to explore, individually or in groups, areas related to their specific professional interests. Prerequisite: permission of instructor. 1-4 cr.

## **Applied Music for Graduate Credit**

The following courses offer further development of technique, music interpretation, and repertory on the various instruments. Emphasis may also be directed toward the functional use of the instrument in the school room. Prerequisite: student must exhibit sufficient proficiency to warrant graduate study and permission of the department chairman and the student's graduate adviser. Audition required. A student may register for credit in the same courses in successive semesters with the approval of the major adviser. Music staff. 1-2 cr.

**841 (841). GRADUATE VOICE**

**842 (842). GRADUATE PIANO**

**843 (843). GRADUATE HARPISCHORD**

**844 (844). GRADUATE ORGAN**

**845 (845). GRADUATE VIOLIN, VIOLA**

**846 (846). GRADUATE VIOLONCELLO, STRING BASS**

**847 (847). GRADUATE WOODWIND**

**848 (848). GRADUATE BRASS**

**849 (849). GRADUATE PERCUSSION**

**850 (850). GRADUATE HARP**

## **855. INTRODUCTION TO BIBLIOGRAPHY**

An intensive survey of basic reference works, music periodicals, collected editions, series, treatises, books on musical instruments and performance practice, and the important monographs on major composers from Machaut to Schoenberg. A reading knowledge of German and French is very useful. Ms. Rasmussen, Mr. Wicks. 3 cr.

## 856. READINGS IN MUSIC HISTORY: ANTIQUITY TO 1600

An opportunity to read and study in detail a restricted number of monographs and editions. Mr. Polk, Mr. Wicks. 3 cr.

## 857. READINGS IN MUSIC HISTORY: 1600-1820

An opportunity to read and study in detail a restricted number of monographs and editions. Mr. Polk, Mr. Wicks. 3 cr.

## 858. READINGS IN MUSIC HISTORY: 1820 TO THE PRESENT

An opportunity to read and study in detail a restricted number of monographs and editions. Mr. DeVoto, Mr. Grishman. 3 cr.

## 891-892. RESEARCH SEMINAR

Guidance in individual research projects. Prerequisite: permission of instructor. Variable cr.

## 893. THEORY SEMINAR

Through reading, analysis, and composition, the student is acquainted with music theory from the Middle Ages to Monteverdi. Mr. Polk, Mr. Wicks. Prerequisite: permission of instructor. 3 cr.

## 894. THEORY SEMINAR

Theory and practice from the Baroque to contemporary music. Performance practice in the Baroque and later periods. Score analysis. Mr. Rogers. Prerequisite: permission of instructor. 3 cr.

## 895. INDEPENDENT STUDY IN THE HISTORY AND THEORY OF MUSIC

This course provides the opportunity for especially qualified students to investigate with guidance specific areas of their scholarly concern. Prerequisite: permission of instructor. 1-4 cr.

## Music Education (72)

### 741-742. TECHNIQUES AND METHODS IN CHORAL MUSIC

Problems in the organization and performance of high school, college, and community choruses. Techniques of choral conducting and rehearsal, repertory, and materials. 2 cr.

### 743. MATERIALS AND METHODS IN PIANO MUSIC

Gives potential piano teachers a coherent but flexible approach to the instruction of students of different ages and levels of talent through evaluation of methods and materials and discussion of the role of the private teacher. 2 cr.

### 745-746. TECHNIQUES AND METHODS IN STRING INSTRUMENTS

Class and individual instruction. Four hours practice per week required. Intensive training on the violin, viola, cello, and double bass, enables participants to perform in string ensembles. Classroom procedures, establishment of string programs, and evaluation of available methods materials. 2 cr.

### 747-748. TECHNIQUES AND METHODS IN WOODWIND INSTRUMENTS

Basic fundamentals of performance, class instruction, associated acoustical problems, and study of woodwind literature. First semester: clarinet, flute, and saxophone. Second semester: double-reed instruments. 2 cr.

### 749-750. TECHNIQUES AND METHODS IN BRASS INSTRUMENTS

A basic course in embouchure formation, tone, tonguing, fingering, flexibility, accuracy, and range development as applied to the trumpet or baritone horn, French horn, and trombone; methods, studies, solos, and ensembles most likely to be useful with grade school, junior high school, and high school players of brass instruments. Qualified advanced students may elect honors work in composition, arranging, and ensemble coaching. 4 cr.

### 751. TECHNIQUES AND METHODS IN PERCUSSION INSTRUMENTS

Basic performance skills on snare drum, timpani, mallet instruments and the other percussion instruments used in bands and orchestras. Materials and methods of instruction. 2 cr.

### 785. MUSIC FOR THE ELEMENTARY CLASSROOM TEACHER

Designed for the non-specialist. The correlation and integration of music in the school curriculum, and the basic skills and techniques necessary. 4 cr.

### 787-788. THE TEACHING OF ELEMENTARY AND MIDDLE SCHOOL MUSIC

Aims, scope, and organization of materials and activities in the elementary and middle schools. Modern trends in educational philosophy; development of the child's voice; demonstration of materials and methods for the various grades. Observation and teaching in schools. 2 cr.

# Occupational Education

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## **791-792. THE TEACHING OF SECONDARY SCHOOL MUSIC**

Educational principles applied to music teaching and learning; curriculum organization for junior and senior high school. Adolescent voice, voice classification, selection of vocal and instrumental materials, and building unified concert programs. Problems of administration; management; relationship of the teacher to school and community. Observation of secondary school music programs. 2 cr.

## **795. SPECIAL STUDIES IN MUSIC LITERATURE**

Presumes a sound musical background. Barring duplication of material, this course may be repeated for credit. Prerequisite: permission of instructor. 1-4 cr.

## **796. ORGANIZATION AND ADMINISTRATION OF SCHOOL MUSIC GROUPS**

Problems of organizing and administering school orchestras, bands, glee clubs, choruses, and small ensembles; objectives, motivation, schedule, discipline, equipment, programs, finances, rehearsal techniques, contests and festivals, materials, personnel selection, and grades. 4 cr.

## **883. INSTRUMENTAL LITERATURE AND ITS PERFORMANCE**

Exploration of representative solo and ensemble music for string, wind, and percussion instruments. Typical literature from each period of music is studied. As much as is possible, live performance is included; recordings are used as required. Detailed attention given to interpretation. Project required. Mr. Grishman, Mr. Hettinger. 3 cr.

## **884. CHORAL LITERATURE AND ITS PERFORMANCE**

Analysis, discussion, and conducting of excerpts from choral masterpieces from all major periods and styles. Students will have the opportunity to act as assistant conductors for some of the choral organizations on campus. Evaluation of current high school and college repertoires. Mr. Howard. 3 cr.

## **895. SPECIAL PROJECTS IN MUSIC EDUCATION**

Independent study, investigation, or research in Music Education. Creative projects may be included. Mr. Howard, Mr. Whitlock. Prerequisite: permission of instructor. 1-4 cr.

# Occupational Education (23)

**Chairman:** William H. Annis

**PROFESSORS:** William H. Annis, Maynard Heckel

**ASSOCIATE PROFESSOR:** Jesse James

**ASSISTANT PROFESSOR:** Nicholas L. Paul

**THOMPSON SCHOOL PROFESSOR:** Paul A. Gilman

**THOMPSON SCHOOL ASSOCIATE PROFESSOR:** Lewis Roberts, Jr.

The Master of Occupational Education degree is designed for teachers and administrators of occupational education and County Cooperative Extension Service personnel, and others in adult education. This degree has been expanded to utilize the faculties and facilities of UNH, Keene State College, and Plymouth State College. Students may register at any of these campuses for the degree. Faculty from at least two different campuses must be represented on the student's graduate committee. Applicants must submit scores achieved on either a Graduate Record Examination aptitude section or Millers Analogies Test. All students are required to take a qualifying examination prior to completing 12 semester hours of credits. This experience will be used to identify areas for further study consistent with the student's career plans and occupational goals.

All students are required to complete a minimum of 30 credit hours of course work which must include Occupational Education 785 and 786. Students may elect to write a thesis which may receive 6-10 credits. All students must pass a comprehensive examination for completion of the program.

The program is coordinated by a committee composed of Robert E. Wenig, Keene; Regis Horace, Plymouth; William H. Annis, UNH; Richard Barker, State Department of Education; and Raymond L. Erickson, dean, UNH Graduate School.

## **750. SHOP ORGANIZATION AND CONTROL METHODS**

Efficiency in the control of instruction, equipment, and materials. 4 cr.

## **783. PREPARATION FOR CONDUCTING AND SUPERVISING ADULT-EDUCATION PROGRAMS**

Techniques of needs identification, program planning; teaching methods, supervision, and evaluation. Prerequisite: Oc. Ed. 550 or permission of instructor. 4 cr.

## **784. THE COMMUNITY-JUNIOR AND VOCATIONAL-TECHNICAL COLLEGES**

Rise and development of community-junior colleges and two-year vocational-technical colleges in American education; their history, potential, philosophy, and functions. 4 cr.

## **785. ADVANCED METHODS AND MATERIALS OF INSTRUCTION**

Organization of instruction to meet student needs; development and use of resource files and instructional materials; evaluation. Open to teachers of vocational-technical education and others by permission of instructor. 4 cr.

## **786. CONCEPTS OF OCCUPATIONAL EDUCATION**

Development of vocational-technical education in the U.S.; socio-economic influences responsible for its establishment. Federal and state requirements for secondary and post-secondary schools. Coordination of programs with general education and other vocational fields. 4 cr.

## **791. PLANNING FOR TEACHING**

Organization of materials of instruction to meet group and individual needs. Techniques of instruction, planning for teaching, the function of consulting committees, working with youth groups, program evaluation. Course is scheduled concurrently with Education 694. Prerequisite: Oc. Ed. 650. 4 cr.

## **796. INVESTIGATIONS IN OCCUPATIONAL EDUCATION**

1) Career Education 2) Secondary Education 3) Post-Secondary Education 4) Adult Education 5) Extension Education 6) Exemplary Programs 7) Cooperative Education Programs 8) Disadvantaged and Handicapped Education Programs. Student-selected problems in one of the areas listed. Elective after consultation with the instructor. Hours to be arranged. May be repeated. 2 to 4 cr.

## **798. OCCUPATIONAL EDUCATION SEMINAR.**

Discussion of current issues, problems, and research and development in Oc. Ed. Students, faculty, and other personnel are utilized as discussion leaders. Required of Oc. Ed. majors and minors. 0 cr.

## **802. METHODS OF TEACHING POWER AND MACHINERY IN OCCUPATIONAL EDUCATION**

Teaching the servicing and maintenance of the agricultural power and machine complex as it relates to the production and non-production phases of vocational agriculture. The development of teaching plans, techniques of instruction, and the development of multi-media teaching units will be stressed. 3 cr.

## **804. PROGRAM PLANNING IN OCCUPATIONAL EDUCATION**

A systematic approach to the development of course materials for Occupational Education. Topics included are: occupational analysis, establishing performance objectives, selection of content, development of supplemental material, and evaluation. Prerequisite: a course in teaching methods or permission of instructor. 3 cr.

## **805. THE DEVELOPMENT OF COOPERATIVE EDUCATION PROGRAMS IN OCCUPATIONAL EDUCATION**

Topics included are: relationship with community; student selection and development of individual programs; the supervision and evaluation of these programs. 4 cr.

## **807. ORGANIZATION AND SUPERVISION OF YOUTH ORGANIZATIONS**

The purposes and organization of youth organizations, establishing the local organization, planning and developing a program of work, ways and means of improving the local organization, and methods of evaluation. 4 cr.

## **809. COMMUNITY ORGANIZATION AND PUBLIC RELATIONS**

The composition, purposes, and objectives of the various social and economic organizations operating in local communities. The importance of their membership to the general welfare of the area and the development of a public relations program. 4 cr.

## **811. INTERNSHIP IN OCCUPATIONAL EDUCATION**

Internship in a field of occupational education either in methodology of teaching or technical subject matter. Students may elect internship only after completing the qualifying examinations for the master's degree with permission of the candidate's major adviser. 0-8 cr. May be repeated up to 8 cr.

## **812. INTRODUCTION TO RESEARCH**

The course is designed to develop a knowledge and understanding which will contribute to the effective use of research in teaching and administering occupational education. The research process will be examined in terms of selection and formulation of research problems, design, techniques of data collection, analysis, and inter-relation of data and reporting. 4 cr.

## **(895). INDEPENDENT STUDY IN OCCUPATIONAL EDUCATION**

Individual study problems in various phases of occupational education. Prerequisite: permission of staff. 2-6 cr. May be repeated.

## **899. MASTER OF OCCUPATIONAL EDUCATION THESIS**

6-10 cr.

# Physical Education

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## Physical Education (40)

**Chairman:** Robert Kertzer

**ASSOCIATE PROFESSORS:** Katherine Amsden, Gavin H. Carter, Phyllis A. Hoff, Robert Kertzer, Robert E. Wear, Walter E. Weiland

**DIRECTOR OF GRADUATE PROGRAM:** Walter E. Weiland

The Department of Physical Education, in the School of Health Studies, offers a graduate program leading to the degree of Master of Science. Admission to graduate study is granted only after evaluation and approval by the Graduate School and the department. This evaluation is based on the applicant's undergraduate preparation, academic record, Graduate Record Examination scores (student must submit GRE scores for the aptitude test), plus letters of recommendation. An applicant must be an above-average student and have been graduated from an accredited college or university with a minimum of 24 credits of theory work in Physical Education. Applicants who have not majored in Physical Education as undergraduates, or who have not met specific course prerequisites, should expect to take additional undergraduate work without receiving graduate credit.

A minimum of 30 approved graduate credits including a thesis (24 graduate course credits plus 6 thesis credits) are required. Physical Education 801 and Resource Economics 701 or a comparable statistics course (upon approval of graduate adviser) are required of all degree candidates. At least 6 graduate credits, in addition to statistics, must be taken outside of the Department of Physical Education. At least 11 graduate credits, in addition to Physical Education 801, must be taken in the Department of Physical Education. Each student is expected to demonstrate competency in formulating and developing a thesis problem which must be approved by the adviser and thesis committee. An oral defense of the thesis is required.

Several courses are available in each of the following areas: 1) exercise physiology, and 2) motor learning. In addition to these two areas of program emphasis, courses are offered in curriculum planning and in the historical, cultural, and social foundations of human movement and sport. Thesis topics need not be restricted to the two areas of program emphasis. The program is sufficiently flexible to satisfy special interests and abilities of the student. With the help of the faculty adviser, the student's program will be individually planned.

### 720. INTERPRETATION AND ASSESSMENT OF PHYSICAL FITNESS

Planning and implementation of programs of conditioning and fitness in the general program of education in the school. Personal fitness; components of physical fitness and conditioning; current tests; rehabilitation of individuals of all ages, particularly in college and adult programs. 4 cr.

### 730. CURRICULUM PLANNING IN PHYSICAL EDUCATION

Criteria and factors involved in planning and construction of school programs. 4 cr.

### 775. PERCEPTUAL MOTOR LEARNING

Variables affecting the learning and performance of skilled activity; ability and motivational characteristics of the learner; processes for skill acquisition. Prerequisite: Psychology 401. 4 cr.

### 780. PSYCHOLOGICAL FACTORS IN SPORT

Factors of outstanding athletic achievement; psychological variables in competition; the actions and interactions of sport, spectator, and athlete. Prerequisite: Psychology 401 or P.E. 775, and permission of instructor. 4 cr.

### 791. HISTORY OF PHYSICAL EDUCATION

From ancient Egypt to modern times. Influences of Greece, Rome, the Renaissance and Reformation periods, and modern European Nationalism. Analysis of events and the beliefs of leaders in the development of systems of physical education. 4 cr.

### (801). RESEARCH METHODS IN PHYSICAL EDUCATION

Designed to acquaint the student with the scope and techniques of research in physical education and to establish the relationship of physical education research to research in education and the social and biological sciences. Topics covered will include the Computation Center resources, methods of research, hypothesis formulation, and the format of the research report. Students will have the opportunity to read current research in physical education. Prerequisite: Physical Education 668, Measurement Procedures in Physical Education, or equivalent. 4 cr.

### 831. CONDITIONING FOR MAXIMUM PERFORMANCE

Examination of the anatomical and physiological factors related to maximum physical performance. Evaluation of present programs of training. Prerequisite: Physical Education 620, Physiology of Exercise, or equivalent. 4 cr.

### 841. SOCIAL DIMENSIONS OF SPORT

The study of sport as described from a social-cultural, action-system frame of reference. Study and discussion will begin with the play element in culture and the origin of sport. The problem of sport will be discussed on the level of cultural values and their related social structure to show how sport is bound to society and structured by general culture. Prerequisite: Sociology 400, Introductory Sociology, or equivalent. 4 cr.



## 850. SEMINAR IN MOTOR LEARNING

Development of a taxonomy of motor skills, discussion of current issues in motor-learning research, and analysis and evaluation of models of skill learning. Prerequisite: P.E. 775 or equivalent. 4 cr.

## 895, 896. ADVANCED STUDIES

The sections of this course provide for advanced work either on a group-seminar or an independent-study basis. Course emphasis will be directed on investigation, presentation, and discussion of recent studies of special concern to physical education. The exact topics for study will vary from semester to semester; they will be selected to meet the needs and interests of the students. 2-6 cr.

## 899. MASTER'S THESIS

6 cr.

## Physics (53)

**Chairman:** John E. Mulhern, Jr.

**PROFESSORS:** Edward L. Chupp, Robert E. Houston, Jr., Richard L. Kaufmann, John A. Lockwood, Robert H. Lambert, Lyman Mower, John E. Mulhern, Jr., William R. Webber

**ASSOCIATE PROFESSORS:** Roger L. Arnoldy, L. Christian Balling, David G. Clark, John F. Dawson, Harvey K. Shepard, Robert E. Simpson

**ASSISTANT PROFESSORS:** Edmond C. Roelof, Richard N. St. Onge, John J. Wright

**GRADUATE ADVISER:** Robert H. Lambert

The physics department offers courses leading to three graduate degrees: Master of Science for Teachers, Master of Science, and Doctor of Philosophy. Graduate students entering in the Master of Science and Doctor of Philosophy programs are expected to demonstrate a proficiency in undergraduate work equivalent to that of the senior year in Physics at the University of New Hampshire.

All graduate students in Physics, except M.S.T. degree students, are required to take a preliminary, comprehensive, written qualifying exam at the beginning of the fall semester of their second year. This exam will emphasize quantum mechanics, electricity and magnetism, and classical mechanics at the undergraduate and first-year graduate level. It will be given on two days, each part being approximately four hours in duration.

On the basis of their performance on this examination students may qualify at the M.S. or Ph.D. levels. Students who fail to qualify at either level must take the written examination a second time in

February of the same academic year. Students are allowed two attempts to pass the qualifying exam. Ph.D. students qualifying in the written exam will be required to take an oral exam within one month of passing the written examination.

## Master of Science for Teachers

The degree of Master of Science for Teachers is offered for candidates who satisfy the general admission requirements (see page 10) or who hold a secondary school teacher certification in physics or in general physical science. The courses leading to this degree will normally be chosen so as to improve the candidate's ability to teach physics or general physical science at the secondary school level. These courses should total at least 30 semester hours and should be chosen in consultation with the graduate adviser in physics.

M.S.T. students are not required to take the qualifying examination. Persons interested in this degree should confer with the department chairman or graduate adviser.

## Master of Science Degree

For admission to graduate study in Physics leading to a Master of Science degree, the student should have completed 24 to 30 semester hours of undergraduate courses in physics. Suitable undergraduate preparation in mathematics is essential to graduate study in physics and should include differential equations, linear algebra, and advanced calculus. Candidates for admission are also required to take the Graduate Record Examination (both the aptitude test and the advanced test in Physics). The results of this examination will be used in conjunction with transcripts to evaluate the applicant's undergraduate training. The courses required for a Master of Science degree include Physics 833, 839, 841, and 843. All M.S. students are required to take the qualifying examination. Candidates may select one of the following two options:

1) Complete 30 semester hours of courses chosen in consultation with the graduate adviser.

2) Complete 24 semester hours of courses chosen in consultation with the graduate adviser, complete a thesis representing the equivalent of 6 semester hours work, and pass an oral examination on the thesis.

## Doctor of Philosophy Degree

For admission to graduate study in Physics leading to a Doctor of Philosophy degree, the student should satisfy the same general admission requirements as for a Master of Science degree. In addition, he is expected to demonstrate an outstanding proficiency in undergraduate physics. Admission to candidacy for the degree is

# Physics

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based on demonstrated ability in formal course work; satisfaction of the language requirement; experience in teaching, equivalent to at least half-time for one year; and passing of a written and oral qualifying examination as specified above. Finally, upon completion of a thesis, the doctoral candidate will take an oral examination based on the area of research.

The courses required for a Doctor of Philosophy degree consist of: 1) 831-832, 833, 835, 839, 841-842, 843-844, and 2) any additional five full courses at the 800 level, excluding 889-890, 897-898, 899, and 999. (For students doing Ph.D. research in space physics, one of these five courses must be 850 or 852.) Note that 895 may be taken more than once for credit.

The language requirement consists of demonstrating a reading ability in one of the following foreign languages: German, French, or Russian. This requirement may be satisfied by any one of the following methods:

1) Satisfactory performance on the Educational Testing Service foreign language examination.

2) Satisfactory performance on the reading examination administered by the department.

3) After two attempts at either 1) or 2), the requirement may be satisfied only by the completion of a one-year course in the language.

## 607. PHYSICAL OPTICS

Electromagnetic theory of light, interference, diffraction, polarization, related phenomena, and non-linear optics. Prerequisite: Math 528. 4 cr.

## 701. INTRODUCTION TO QUANTUM MECHANICS

Applications to atomic and molecular spectra. Prerequisite: Math 527, 528 and consent of instructor. 4 cr.

## 702. ATOMIC AND NUCLEAR PHYSICS

Natural radioactivity; nuclear reactions and scattering; models of the nucleus; high energy nuclear physics; cosmic rays. Prerequisite: Physics 701. 4 cr.

## 703-704. ELECTRICITY AND MAGNETISM I AND II

Foundation of electromagnetic theory; electrostatics, dielectric theory, electromagnetism, magnetic properties of matter, alternating currents, Maxwell's field theory, and an introduction to electrodynamics. Prerequisite: Math 527, 528 and consent of instructor. 4 cr.

## 831-832. MATHEMATICAL PHYSICS

Complex variables, differential equations, asymptotic methods, integral transform, special functions, linear vector spaces and matrices, Green's functions, integral equations, variational methods, numerical methods, and tensor analysis. 3 cr.

## 833. EXPERIMENTAL PHYSICS I

Modern research techniques, including discussion and laboratory exercises in fundamental measurements in optics, electromagnetism, nuclear and atomic phenomenon. Prerequisite: passing an electronics proficiency test or Physics 605. 3 cr.

## 834. EXPERIMENTAL PHYSICS II

Modern research techniques. Prerequisite: Physics 833. 1-3 cr.

## 835. STATISTICAL PHYSICS I

A review of thermodynamics and kinetic theory, followed by an introduction to classical and quantum statistical mechanics. Microcanonical, canonical and grand canonical ensembles, ideal Fermi and Bose gases are among the topics discussed. Prerequisite: Physics 831 and 843 or permission of instructor. 3 cr.

## 836. STATISTICAL PHYSICS II

Basic formulation and application of statistical mechanics to selected physical problems. Prerequisite: Physics 844. 3 cr. (Offered on request.)

## 839. THEORETICAL MECHANICS

Newtonian, Lagrangian, and Hamiltonian formulation of the classical mechanics of particles and rigid bodies, with particular attention to those topics that serve as background for the study of modern physical theories. 3 cr.

## 841-842. ELECTROMAGNETIC THEORY

The formulation and detailed application of electromagnetic theory to physical problems. Prerequisite: permission of instructor. 3 cr.

## 843-844. QUANTUM MECHANICS

Wave mechanical and Dirac formulations of non-relativistic quantum mechanics. Prerequisite: permission of instructor. 3 cr.

## 850. PLASMA PHYSICS I

Topics to be discussed will be selected from the following: magnetohydrodynamics and plasma flow, waves, shocks and discontinuities, instabilities, and adiabatic motion of charged particles. 3 cr.

## 852. PLASMA PHYSICS II

Topics to be discussed will be selected from the following: kinetic theory of plasmas, plasma waves, instabilities, and non-linear plasma phenomena. Offered on request. Prerequisite: Physics 835 or permission of instructor. 3 cr.

## 861-862. ADVANCED QUANTUM MECHANICS

Relativistic wave equations, propagator theory and Feynman diagrams, quantum theory of radiation, second quantization, introduction to quantum field theory and related topics. Prerequisite: Physics 839 and 844. 3 cr. (861-alternate years; offered 1975-76. 862 offered on request.)

## 863-864. NUCLEAR PHYSICS

Introduction to nuclear processes, including nuclear forces, nuclear structure and models, static properties, beta and gamma emission, and nuclear reactions. Selected topics in experimental methods. Prerequisite: Physics 844. 3 cr. (863-alternate years; offered 1976-77. 864 offered on request.)

## 865-866. SOLID STATE PHYSICS

Development of quantum mechanical theory of solids, transport phenomenon, etc. Prerequisite: Physics 843 and 835. 3 cr. (865-alternate years; offered 1975-76. 866 offered on request.)

## 887. COSMIC PHYSICS I

Topics will be selected from the following: ionospheric physics; magnetospheric physics; interplanetary physics; solar physics; cosmic ray physics; radio, x-ray, and gamma-ray astronomy; motion, transport, energy loss, origin, and acceleration of charged particles in the magnetosphere, interplanetary medium, and galaxy; cosmological problems. 3 cr.

## 888. COSMIC PHYSICS II

Extended investigation of one or more of the topics introduced in Cosmic Physics I. Offered on request. 3 cr.

## 889-890. SPACE PHYSICS SEMINAR

Lectures and discussions of current research in the physics of fields and particles in space. 1-3 cr.

## 891, 892. PROBLEMS IN THEORETICAL PHYSICS

May be taken more than once. Offered on request. 3 cr.

## 893, 894. PROBLEMS IN EXPERIMENTAL PHYSICS

May be taken more than once. Offered on request. 3 cr.

## 895, 896. SPECIAL TOPICS

Any special fields of study not covered by the above courses may be included. Choice of topic to be determined by class. May be taken more than once. 1-3 cr.

## 897-898. COLLOQUIUM

Required of all graduate students. Topics to be selected. No cr.

## 899. MASTER'S THESIS

6 cr.

## 999. DOCTORAL RESEARCH

# Plant Science (24)

**Chairman:** Lincoln C. Peirce

**PROFESSORS:** Gerald M. Dunn, Lincoln C. Peirce, Owen M. Rogers, Douglas G. Routley

**ASSOCIATE PROFESSORS:** George O. Estes, J. Brent Loy, Jerry Warren, Otho S. Wells

**ASSISTANT PROFESSORS:** Yun-Tzu Kiang, David W. Koch, James E. Pollard

**ADJUNCT ASSISTANT PROFESSOR:** Merrill B. Hoyle

The graduate research program in Plant Science is concerned with solving basic and applied problems associated with growth of crop plants and their response to the environment. Facilities include laboratories, greenhouses, growth chambers, and two experimental farms.

The program emphasizes two principal disciplines regulating plant growth: 1) breeding and genetics; and 2) physiology and biochemistry. Research and teaching in plant genetics, cytogenetics, and plant breeding are major strengths complemented by University programs in genetics and statistics. A strong research and teaching program is also available in plant physiology, including advanced courses in plant nutrition, metabolism, growth and development, and growth regulations. An increasing number of research projects in the department involve both geneticists and physiologists.

Undergraduates should obtain adequate background in the biological and physical sciences, including botany and chemistry. Students lacking these requirements may be admitted on condition that certain courses be completed without graduate credit.

# Plant Science

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Candidates for the Master of Science degree will be required to prepare a thesis and to pass an oral examination. Candidates for the Ph.D. degree must take a written and/or oral qualifying examination and a final oral examination on the dissertation, in which the student must demonstrate his or her ability to do original research in the area of specialization. Supervised teaching or its equivalent is required of each master's and doctoral student.

## Advanced Plant Physiology

### 708. PLANT NUTRITION

Nutritional aspects of higher plants; uptake, translocation, and metabolic role. Prerequisite: plant physiology, soils. Mr. Estes. 3 lec/1 lab/4 cr. (Alternate years; offered 1976-77.)

### 762. PLANT METABOLISM

Function, occurrence, synthesis, and degradation of plant constituents; respiration and photosynthesis; metabolism of nitrogenous and aromatic compounds; biochemical mechanisms in seed dormancy, fruit ripening, and disease resistance. Prerequisite: Biochemistry 601 or 751. Mr. Routley. 2 or 4 cr. (Alternate years; offered 1976-77.)

### 863. PLANT GROWTH AND DEVELOPMENT

Biochemistry and physiology of growth and development; current research; independent laboratory projects. Mr. Pollard. Prerequisite: Plant Physiology and Biochemistry. 2 lec/2 lab/4 cr. (Alternate years; offered 1975-76.)

## Advanced Genetics (See Genetics Program)

### 705. POPULATION GENETICS

Population growth and regulation; distribution of genes; factors affecting gene frequency; genetic load; cost of natural selection; ecological genetics. Prerequisite: Zoology or P.S. 604 and Forest Resources 528, or equivalents, or permission of instructor. Mr. Kiang. 4 lec/4 cr. (Alternate years; offered 1976-77.)

### 732. PLANT DEVELOPMENTAL GENETICS

Gene action in relation to development in plants; isozymes and differentiation; chromosomal proteins and gene regulation; temporal specificity of gene action; nuclear-cytoplasmic interactions; chemical gradients and gene activation. Prerequisite: introductory genetics and physiology. 3 lec/1 lab/4 cr. (Alternate years; offered 1975-76.)

### 740. EVOLUTIONARY BIOLOGY

The synthetic theory of evolution in the origin of life, species, and higher groups; sources of genetic variability; population structure; causes of evolution; evolution of communities; molecular evolution and rates of evolution. Prerequisite: Zoology or P.S. 604, or equivalent, or permission of instructor. Mr. Kiang. 4 lec/4 cr. (Alternate years; offered 1975-76.)

### 773. METHODS AND THEORY OF PLANT BREEDING

Plant breeding systems for qualitative and quantitative plant improvement. Prerequisite: P.S. or Zoology 604, Forestry 528, or permission of instructor. Mr. Peirce. 3 lec/3 cr. (Alternate years; offered 1976-77.)

### 851. PLANT GENETICS

Linkage, euploidy, aneuploidy, cytoplasmic inheritance, mutation, and genetics of disease resistance. Mr. Dunn. Prerequisite: Genetics. 3 cr. (Alternate years; offered 1975-76.)

### 853. CYTOGENETICS

Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory techniques in cytogenetic analysis. Mr. Rogers. Prerequisite: Genetics, Cytology. 2 lec/1 lab/3 cr. (Alternate years; offered 1976-77.)

## General Offerings and Independent Studies

### 776. RADIOISOTOPE TECHNIQUES FOR LIFE SCIENCES

Application of radioisotopes to biological systems; detection and measurement, liquid scintillation spectrometry and autoradiography, gamma-ray spectrometry, radiochromatogram scanning, and tissue distribution of radioisotopes. Prerequisite: inorganic chemistry and physics. Mr. Estes. 2 lec/2 lab/4 cr.

### 795, 796. ADVANCED TOPICS IN PLANT SCIENCE

Independent research, study, or group discussion. A) Physiology, Msrs. Estes, Koch, Pollard, Routley. B) Genetics, Msrs. Estes, Koch, Pollard, Routley. C) Plant Utilization, Staff. Prerequisite: permission of instructor. 2 or 4 cr.

### 877 (877). SUPERVISED TEACHING FOR GRADUATE STUDENTS

Techniques of planning and presenting classroom and laboratory material. Students will prepare and present four contact hours of lecture and/or laboratory material per semester in the specific course in which the student is participating. Bi-weekly seminars to discuss teaching techniques and problems. One credit or its equivalent required of each Plant Science master's and Ph.D. candidate. Plant Science graduate students only. Prerequisite: permission of instructor. 1 cr. Cr./F.

### **895-896. RESEARCH IN PLANT SCIENCE**

Advanced investigations in a research subject, exclusive of thesis. Staff. 1-4 cr.

### **897-898. GRADUATE SEMINAR**

Library research and discussion of current topics of Plant Science. Required of all graduate students majoring in Plant Science. Staff. 1 cr.

### **899. MASTER'S THESIS**

A thesis requiring study in depth of a phase in Plant Science. Required of all master's candidates in Plant Science. 6-10 cr.

### **999. DOCTOR OF PHILOSOPHY THESIS**

Dissertation reflecting independent research in a phase of Plant Science is required. Credit received upon completion.

## **Political Science (75)**

**Chairman:** Lawrence W. O'Connell

**PROFESSORS:** Robert B. Dishman, Bernard K. Gordon, George K. Romoser, Allan A. Spitz

**ASSOCIATE PROFESSORS:** John R. Kayser, David L. Larson, Lawrence W. O'Connell, Frederic W. Wurzburg

**ASSISTANT PROFESSORS:** Robert E. Craig, David W. Moore, B. Thomas Trout, Susan O. White

A candidate for admission to graduate study in the Department of Political Science normally is expected to have majored either in Political Science or a field closely related, and to have achieved an undergraduate academic record of some distinction. In unusual and exceptional cases and where undergraduate preparation has been insufficient, a candidate may be admitted provided that s/he follows without credit a program of study approved by the chairman. In all cases the Graduate Record Exam is required of candidates who seek to be considered for admission. The department offers the Master of Arts in Political Science and the Master of Public Administration.

### **Master of Arts (M.A.) in Political Science**

The program leading to the Master of Arts in Political Science is normally to be completed in a single calendar year (an academic year plus the following summer) and is based on three elements: the development of advanced knowledge in at least three fields of the discipline in which the department offers its courses and seminars; the ability to conduct and complete an individual program of research

at a high level; and familiarization with modern methodology in the discipline. Accordingly, every candidate will complete a suitably arranged program consisting of eight courses and seminars (32 credits) and a master's thesis (which carries four credits), for a total of 36 credits. Of the eight courses, one must be Political Science 893, Contemporary Political Analysis; and the second, Political Science 899, Sec. 1, Directed Research and Study, normally to be taken in the second semester of the candidate's residence. The master's thesis is expected to be within the field in which the candidate has undertaken Directed Study and Research, and generally is expected to derive from the same topic. Topics must be approved by a committee selected by the chairman.

An essential requirement is that each candidate must arrange his program so that it includes at least one seminar (Political Science 897, 898) in each of three fields of the discipline emphasized by the department (Political Thought; American Politics; Comparative Politics; and International Politics). The remaining courses may be chosen according to the candidate's interests and needs, and two may be taken in a related field outside the department. Where a candidate lacks proficiency in tools of quantitative analysis or a foreign language essential to his program of study and research, he will be required to attain and demonstrate to the thesis adviser proficiency in the needed skill.

### **Master of Public Administration (M.P.A.)**

The Master of Public Administration is an interdisciplinary degree designed principally for individuals intending to pursue careers in local, state, or national government service in the U.S. or other governments. Candidates will be expected to complete eight full courses (32 credits) and a six-week internship program, normally during the summer after the completion of formal course work. Candidates who have had prior appropriate responsibility in public administration may apply for a waiver of the internship requirement. A Recreation and Parks option which draws upon the resources of that department is offered as an interdisciplinary program for the degree. Students pursuing this option are held to the general degree requirements, and usually take courses in Recreation and Parks to fulfill the requirements for work outside the Political Science department. The internship is served with an appropriate Recreation and Parks agency.

Of the eight courses, at least two shall be chosen from the courses and seminars in public administration offered by the department, and three from other Political Science courses according to the needs and interests of the candidate. Normally, one course shall be in statistics (Resource Economics 701 is recommended but other statistics offerings may fill this requirement with approval of the program adviser). Those candidates who have successfully completed

## Political Science

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comparable undergraduate work in statistics may be exempted from this requirement. The remaining two courses shall be chosen from outside the department in related fields such as economics, administration, resource economics, sociology, and recreation and parks.

Candidates for advanced degrees are expected to take courses at the 800-level in Political Science, and to maintain a passing grade (B-) in all courses.

Required courses and an appropriate range of electives are offered every year.

### Political Thought

#### **700/800. POLITICAL THOUGHT AND CULTURE**

Relation between man's artistic and social endeavors and forms, and his political thought. Study of politics and literature through figures such as Aristophanes, Swift, Shakespeare, and contemporary writers. 4 cr.

#### **701/801. THE SCIENTIFIC STUDY OF POLITICS: ITS PHILOSOPHICAL DEVELOPMENT**

Formulations and criticisms of the scientific study of politics beginning with Aristotle, and reviewing the development of modern scientific method from Bacon to the present. 4 cr.

#### **702/802. IDEOLOGIES AND DISSENT IN AMERICA AND THE WEST**

Ideas and movements of protest since the late 19th century, particularly attacks upon liberal democratic theory and practice. 4 cr.

#### **797, 798/897, 898. SECTION I: SEMINAR IN POLITICAL THOUGHT**

Advanced treatment and individual research. Prerequisite: senior or graduate standing. 4 cr.

### Scope and Methods

#### **793/893. CONTEMPORARY POLITICAL ANALYSIS**

Various forms of contemporary political analysis, with attention both to methods of empirical inquiry and explanation and to modes of justification. Intended for advanced students; normally open to seniors and graduate students only. 4 cr.

#### **820. METHODS OF RESEARCH IN POLITICAL BEHAVIOR**

Methodology and techniques in evaluating political behavior, surveys, experimental designs, and basic data processing. Aspects of computer technology and political research. 4 cr.

### American Politics

#### **730/830. ADMINISTRATIVE PROCESS**

Principle concepts of administrative behavior and public bureaucracy. 4 cr.

#### **731/831. URBAN AND METROPOLITAN POLITICS**

Planning and management of the urban community. Intergovernmental relations, administrative functions, and general urban problems. 4 cr.

#### **732/832. PSYCHOLOGY OF POLITICAL BEHAVIOR**

Cultural, social, economic, and emotional forces influencing the citizen's political activity. 4 cr.

#### **733/833. INTERGOVERNMENTAL RELATIONS AND FEDERALISM**

Interrelationship of national, state, and local governments in the American federal system. Patterns of regionalism, interstate cooperation and conflict, and the evolution of federal relations. 4 cr.

#### **735/835. AMERICAN PLURALISM**

Focus on a particular problem in American politics, such as the role of private power, interest groups, participation and representation, civil liberties, and political freedom. 4 cr.

#### **797, 798/897, 898. SECTION (2): SEMINAR IN AMERICAN POLITICS** 4 cr.

#### **797, 798/897, 898. SECTION (6): SEMINAR IN PUBLIC ADMINISTRATION**

Advanced treatment, including individual research and internship opportunities in problems of administration. 4 cr.

### Comparative Politics (A. Area Studies)

#### **750/850. POLITICS IN WEST EUROPE**

Aspects of the politics of the major continental powers. 4 cr.

#### **751/851. MAJOR COMMONWEALTH STATES: BRITAIN, CANADA, AUSTRALIA**

Comparison and analysis of major governments influenced by the British parliamentary system; federal systems and ethnic diversity as exemplified by French Canada. 4 cr.

**752/852. POLITICS IN THE USSR AND EAST EUROPE**

Comparative analysis of the background, structure, and underlying issues of political systems. Ideological bases, political history, and contemporary trends. 4 cr.

**753/853. MAJOR GOVERNMENTS OF EAST ASIA: CHINA AND JAPAN**

Political development within the historical context; related economic, social, and cultural variables. Comparative perspective where appropriate. 4 cr.

**755/855. GOVERNMENT AND POLITICS IN SOUTHEAST ASIA**  
4 cr.**797, 798/897, 898. SECTION 3: SEMINAR IN COMPARATIVE POLITICS OF NATIONS**

Includes advanced analysis and individual research on national or regional politics. Prerequisite: senior or graduate standing. 4 cr.

**Comparative Politics (B. Problems in Comparative Politics and Development)****757/857. POLITICAL DEVELOPMENT AND POLITICAL DECAY**  
Issues and concepts of political change. 4 cr.**758/858. COMPARATIVE JUDICIAL PROCESSES**

Court systems and their relationships to political life; political, social, and structural influences on judicial behavior; law and human behavior. 4 cr.

**759/859. COMPARATIVE LEGISLATIVE BEHAVIOR**

Role, organization, operation, and conduct of legislatures in national political systems. 4 cr.

**760/860. COMPARATIVE COMMUNIST SYSTEMS**

Interest groupings, elites, and decision-making; political behavior within communist international organizations; intraparty distinctions between ruling and non-ruling communist parties. 4 cr.

**761/861. POLITICAL SOCIOLOGY**

Impact of social structure and change upon political behavior, including elite/mass relationships, integration and instability. Major empirical findings and theoretical contributions, from Marx and Weber to the present. 4 cr.

**797, 798/897, 898. SECTION 4: SEMINAR IN COMPARATIVE POLITICS**

Includes advanced analysis and individual research. Administration, foreign policy, political parties, and governmental institutions. Prerequisite: senior or graduate standing. 4 cr.

**International Politics****775/875. THEORIES OF INTERNATIONAL POLITICS AND INTEGRATION**

General explanations for the behavior of nations and of the theory and practice of supra-national integration. Theories of peace and security and community building at the international level. Concepts and practices of arms limitation and conflict resolution. 4 cr.

**776/876. STRATEGY AND NATIONAL SECURITY POLICY**

Defense and deterrence among the major powers; impact of modern weapons on war and arms limitation. Armed forces role in shaping defense policy. 4 cr.

**777/877. INTERNATIONAL LAW**

Formalized processes for regularizing state behavior; development of norms based on custom, precedent, and formal institutions, as in treaties and cases. Arms reduction and limitation arrangements; inspection; and other formal procedures designed to preserve peace. 4 cr.

**778/878. INTERNATIONAL ORGANIZATION**

Collective security and other forms of cooperation among nations through international organizations such as the United Nations and its predecessors, and through regional bodies. 4 cr.

**779/879. FOREIGN POLICIES IN EUROPE**

East-West relations, security alliances, economic and political cooperation, and the impact of domestic change and super-power relationships on international politics in Europe. 4 cr.

**780/880. FOREIGN POLICIES OF THE USSR AND THE SOVIET BLOC**

Foreign policy and strategy in its national and European coalition context; Soviet-American and Sino-Soviet relations. 4 cr.

**781/881. INTERNATIONAL POLITICS OF EAST ASIA**

Foreign and defense policies emphasizing Japan, China, and selected Southeast Asian nations, including their efforts at cooperation. 4 cr.

# Psychology

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## 797, 798/897, 898. SECTION 5: SEMINAR IN INTERNATIONAL POLITICS

Advanced analysis and individual research; emphasis on developments in theory. Prerequisite: senior or graduate standing. 4 cr.

## 899. SECTION 1: DIRECTED RESEARCH AND STUDY 4 cr.

## 899. SECTION 2: MASTER'S THESIS 4 cr.

### Related Courses in Recreation and Parks

#### 870. ADMINISTRATIVE INTERNSHIP

To provide a practical administrative experience in a specified professional area of interest. Prerequisites: MPA—Specialization in Recreation and Parks major and permission of instructor. 4 cr. Cr./F.

#### 885. COMPREHENSIVE PLANNING

Basic principles of local, county, and regional leisure and tourist planning with emphasis on legislative aspects, court decisions, administrative organization, zoning, land use, and other master planning considerations as they relate to recreation programming and resource development. Prerequisite: permission of instructor. 4 cr.

#### 890. SPECIAL TOPICS AND PROJECTS

Advanced study in specific areas which may involve formal classes, seminars, or independent projects. Prerequisite: permission of instructor. 4 cr.

## Psychology (76)

**Chairman:** Ronald E. Shor

**PROFESSORS:** Raymond L. Erickson, John A. Nevin, Ronald E. Shor, Robert I. Watson

**ASSOCIATE PROFESSORS:** Lance K. Canon, Robert G. Congdon, Rand B. Evans, Kirk E. Farnsworth, Peter S. Fernald, G. Alfred Forsyth, Earl C. Hagstrom

**ASSISTANT PROFESSORS:** Gregory J. Bertsch, James R. Davis, John E. Limber, David I. Schickedanz, Marty J. Schmidt, Stephen J. Weber, Daniel C. Williams.

## Doctor of Philosophy

The Department of Psychology offers a four-year program of study leading to the Doctor of Philosophy degree. The basic goal of the program is the development of behavioral scientists who can carry out sound research in an area of specialization and make meaningful contributions to the field of psychology. In addition, a concern with the specific needs of the research psychologist who intends to become a college or university teacher is woven into the program. In the third year, students have the opportunity to teach a small section of introductory psychology under close staff supervision while concurrently enrolled in a teaching seminar that has among its goals a deepening of the student's appreciation of the objective and problems of teaching in the liberal arts.

Areas in which the student may specialize are: history and theory, learning, physiological psychology, perception-cognition, and social psychology. The student's adviser will help the student to plan an effective graduate program, which will typically require four years. Core courses taken by all students include methodology, statistics, and the seminar and practicum in the teaching of psychology. Work outside the department also is included in each student's program. Depth in a particular area is obtained through participation in the graduate courses listed below and by independent study and research conducted under the supervision of a staff member. Psychology 895, 896, Reading and Research in Psychology, is specifically designed to serve this purpose.

Social psychology is an interdisciplinary program operated in conjunction with the Sociology Department. Students are admitted by and must meet the requirements of their respective departments. Their work in social psychology, however, is coordinated by an advisory committee with representatives from both departments and includes course work in both departments.

Prior to the doctoral dissertation, the student will carry out original research that culminates either in a master's thesis or a paper of publishable quality. A master's degree may be awarded upon the successful completion of a program approved by the department and dean of the Graduate School including original research at the master's level. Detailed information concerning language requirements and the qualifying examination for advancement to candidacy for the Ph.D. degree can be obtained from the department.

A student admitted to graduate study must meet the requirements for admission to the Graduate School. In applying for admission to the department's program, candidates must submit Graduate Record Examination scores on the verbal and quantitative sections of the aptitude test and the score on the advanced test in psychology.

To be accepted into the program, the applicant must desire to pursue the doctoral degree and be deemed qualified to do so on the basis of initial selection procedures. The applicant need not neces-



sarily have been an undergraduate major in psychology. However, before beginning a graduate career proper, the applicant must have completed a minimum of 15 undergraduate credits in psychology, including courses in elementary statistics, experimental psychology, learning theory, and systematic psychology.

## Graduate Curriculum in Psychology

The courses and seminars listed below provide the general framework within which the student will develop, with the counsel of his adviser, a program of research and study leading to the doctoral degree. The range and sequence of seminars will vary to some extent with each student, though there will be common features to all programs.

The 700-series courses are not normally taken for graduate credit, though a student may be advised to enroll in one of these courses as a way of improving background in the field. Graduate credit for a 700-series course is permitted only with the previous approval of the student's adviser.

The graduate courses are offered in a two year cycle. All basic courses are offered each year and special courses and seminars are offered every other year. Consult the department for exact schedule.

### 801-802. GRADUATE PROSEMINAR

Students and graduate faculty in Psychology meet every two weeks for a mutual exchange on current issues in psychology. No cr.

### 805-806. RESEARCH METHODOLOGY AND STATISTICS I, II

A consideration of research techniques and problems of methodology in psychology. The first semester stresses the principles of statistical inference, correlational approaches, and their interrelatedness in design. Topics considered include probability theory, linear regression, function-free prediction, the theory underlying statistical inference, parametric and non-parametric tests of significance, and principles of analysis of variance. The second semester extends the correlational approach to the techniques and methodology of multiple regression and considers the appropriate use and theoretical bases of complex designs. Prerequisites: undergraduate statistics and experimental psychology. 3 cr.

### 807. RESEARCH METHODOLOGY AND STATISTICS III

A continuation of Psychology 805-806, covering computer techniques in statistical analysis, factor analysis, and other commonly used multivariate analytical techniques. 3 cr.

### 808. MEASUREMENT AND ASSESSMENT

A seminar devoted to the nature of measurement in psychology. Emphasis is given both to the techniques for evaluating various assessment procedures and to the theory of data. Current issues in the problems of measurement will be discussed and the course will culminate in a project relating the area of measurement to specific content areas of interest to the student. Prerequisite: Psychology 807. 3 cr.

### 812. PSYCHOLINGUISTICS

A seminar concerned with the nature and development of human language. Topics include the logic of explanation in psychology and linguistics, a survey of contemporary linguistic theory, semantic theories, language development, speech perception and production, and the role of language in communication, perception, memory, and thinking. All participants will be expected to develop a viable and interesting research proposal on a problem of their choosing. 3 cr.

### 814. COGNITIVE PROCESSES

A study of the complex mental processes which characterize man. Concept formation, reasoning, problem-solving, symbol use, creative thinking, imagination, fantasy behavior, pathology of thought, consciousness and its alternatives, and the relationship between cognition and effective behavior are among the topics examined in depth. 3 cr.

### 815. PSYCHOLOGY OF PERCEPTION

An information-processing approach to perception is taken. A study is made of the development of perceptual theory and its relationship to current perceptual research. Research and theory are examined as they pertain to issues such as: the definition of the stimulus, selective attention in perception, active vs. passive perception, the interactions between sense modalities in information-process, the development of perception in the individual, methodologies and problems of measurement in perception, the role of adaptation in perception, parallel vs. serial processing of information, the role of peripheral and central mechanisms in perception, and the relationship of perception to other content areas in psychology. Opportunities are given for designing and running perception experiments. 3 cr.

### 816. INFORMATION, FEEDBACK, AND DECISION MAKING

A seminar devoted to the study of the roles of uncertainty and preference in purposive behavior. Theories and research pertaining to three major topics are considered: the roles of information and uncertainty in behavior, the roles and interaction of

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feedback and objectives in structured behavior, and the role of preference and its interaction with uncertainty in decision making. 3 cr.

## **817. SENSORY AND PERCEPTUAL PROCESSES**

An introduction to the sensory psychology of visual and auditory perception. The course is intended to acquaint the student with the major problems of current interest in sensory psychology and provide basic skills necessary to begin sensory-perceptual research. Major topic areas: 1) Physics of visual and auditory stimuli; 2) Sensory Physiology of visual and auditory systems; 3) Basic visual auditory psychophysics; and 4) Study of complex perceptual processes, including pattern vision, color vision and color theory, depth perception and auditory localization. 3 cr.

## **831. PHYSIOLOGICAL PSYCHOLOGY I**

The examination of the concepts and research methods involved in the relationship between the nervous system and behavior. Topics examined include neuroanatomy and the physiological mechanisms of motivation and learning. 3 cr.

## **832. PHYSIOLOGICAL PSYCHOLOGY II**

Continuation of a two-semester sequence examining the concepts and research methods involved in the relationships between the nervous system and behavior. Topics examined include electrophysiological techniques and the analysis of coding in the sensory systems. 3 cr.

## **833. ADVANCED PHYSIOLOGICAL PSYCHOLOGY**

A seminar devoted to an intensive examination of specific topics relating behavior to its physiological correlates. Among the topics considered are receptor functions, cortical mechanisms, memory, neural correlates of drive states, emotional behavior, and intracranial stimulation. Prerequisite: Psychology 831-832 or equivalent. 3 cr.

## **841. PSYCHOLOGY OF LEARNING**

This course has been designed for graduate students lacking a strong undergraduate preparation in the area of learning. Responsibility for instruction is shared by all faculty whose research interests are in the area of learning. Topics include conditioning and other forms of learning, with emphasis on current experimental and theoretical literature. 3 cr.

## **842. STIMULUS CONTROL**

Current research and theory dealing with the control of learned behavior by antecedent and current environmental stimuli. Topics include stimulus generalization, discrimination learning, selective attention, complex operant behavior, and animal psychophysics. Prerequisite: Psychology 841 or equivalent. 3 cr.

## **843. INSTRUMENTAL CONDITIONING AND AVERSIVE CONTROL**

The course examines in depth the theoretical and methodological problems encountered in the study of the acquisition and extinction of instrumental behavior. Topics include: reinforcement theory, partial reinforcement, punishment, escape, avoidance, and biological constraints on conditioning. Each student will choose and prepare a review of the literature on a topic for written and oral presentation. Prerequisite: Psychology 841 or equivalent. 3 cr.

## **844. SEMINAR IN HUMAN LEARNING**

An investigation of learning on the human level. Topics include verbal learning, memory processes, transfer, concept learning, and observational learning. Following a comprehensive treatment of the topics, each student will pursue a specialized area in depth and will present, in both written and oral form, a research proposal for a feasible study in human learning. Prerequisite: Psychology 841 or equivalent. 3 cr.

## **850. METHODS OF SOCIAL PSYCHOLOGICAL ANALYSIS**

An examination of procedures, logic, inferential strength, and potential bias of the various methodologies for studying social behavior. Issues regularly introduced include experimental, quasi-experimental, and non-experimental designs, the laboratory-field continuum, social psychological aspects of interviews and experiments, the nature of artifacts, and other current methodological issues. The course emphasizes the design of social psychological research rather than statistical analysis, though statistical matters regularly arise. Prerequisites: Psychology 805, Sociology 801 or equivalent. 3 cr.

## **851. SOCIAL PSYCHOLOGY**

A seminar devoted to theoretical and experimental support for major topics of current concern. These may include attitude change, power, interpersonal perception and attraction, roles, interaction, and analysis of structure and function in complex social systems. 3 cr.

## **852. ATTITUDE AND ATTRIBUTION IN SOCIAL PSYCHOLOGY**

An in-depth study of various approaches to attitudinal and attributional processes with particular emphasis upon current

theoretical issues. To be examined are theories emerging from the Gestalt-Freud traditions as well as those developing out of the classical and operant-conditioning approaches. Prerequisite: Psychology 851. 3 cr.

## **853. GROUP PROCESS AND SOCIAL INFLUENCE**

An examination of the problems of the individual in the group and the group as a system, with special emphasis on aspects of social influence. This course focuses on social influence as a decision-analysis problem with attention to topics such as conformity, leadership, bargaining and negotiation, group problem-solving, and other variables of group process. Prerequisite: Psychology 851 or permission of instructor. 3 cr.

## **854. SEMINAR IN SOCIAL PSYCHOLOGY**

Intensive coverage of the experimental and theoretical literature in a selected area of basic or applied social psychology. Students will participate directly in the conduct of the seminar by means of individual topical discussions, development and/or execution of research designs, and critical assessment of the current state of the topic area under discussion. Illustrative topics: political behavior, paralinguistics and non-verbal communication, ethnic and racial prejudice, and environmental psychology. May be repeated for credit. Prerequisite: Psychology 851. 3 cr.

## **856. PSYCHOLOGY OF PERSONALITY**

The evolutionary development of the major personality theories, with particular reference to the theoretical, clinical, and experimental contributions to current theories. 3 cr.

## **871. SURVEY OF THE HISTORY OF PSYCHOLOGY**

A general overview of the history of psychology from its beginnings to the end of the era of schools, ca. 1935. 3 cr.

## **872. METHODS AND THEORIES IN HISTORICAL RESEARCH ON THE BEHAVIORAL SCIENCES**

A survey of the main theories and methods employed in historical research with particular emphasis on those most directly applicable to the study of the behavioral sciences. Prerequisite: Psychology 871 or permission of the instructor. 3 cr.

## **873. SYSTEMS, SCHOOLS, AND CONCEPTS IN PSYCHOLOGY**

An analysis of the principle schools of psychological thought viewed within the context of the philosophy of science. Prerequisite: Psychology 871 or permission of the instructor. 3 cr.

## **874. PROBLEM AREAS IN THE HISTORY OF PSYCHOLOGY**

A study in depth into particular men, movements, and concepts in the history of psychological thought. Topics will vary and it is expected that students in the history of psychology program will sample a number of such topics. Prerequisites: Psychology 871, 872, or permission of instructor. 3 cr.

## **875. ARCHIVAL RESEARCH AND THE MANAGEMENT OF MANUSCRIPT COLLECTIONS**

A survey of the basic techniques of archival research including ethical and legal considerations. Training will be given in the organization and management of a small manuscript collection. Laboratory experience will be included. Prerequisites: Psychology 871, 872, or permission of instructor. 3 cr.

## **876. ADVANCED TOPICS IN HISTORICAL METHODS**

A study of methods of historical research with particular emphasis on the development of new quantitative tools and the refining of existing tools. The extension of psychological principles into the history of science will also be discussed. Topics and emphases may vary. May be taken more than once as topics vary. Prerequisites: Psychology 871, 872, or permission of instructor. 3 cr.

## **881. SEMINAR IN DEVELOPMENTAL PSYCHOLOGY**

A seminar devoted to topics of current interest in developmental psychology in the areas of infancy, effects of early experience, cognitive development or social-personality development. Core material will be followed by in-depth study in an area of student's interest. 3 cr.

## **891-892. SEMINAR AND PRACTICUM IN THE TEACHING OF PSYCHOLOGY**

Typical problems encountered in teaching psychology on the college level, including an examination of the implications of the liberal arts philosophy for teaching. Under close supervision of the staff, the student will be given an opportunity to teach an undergraduate section of introductory psychology. The seminar and practicum operate in close coordination throughout the year. Required of all doctoral students, typically during the third year. 5 cr.

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## 894. ADVANCED RESEARCH IN PSYCHOLOGY

Each student will design and conduct original research that culminates in a paper of publishable quality. Completion of either this course or Psychology 899 will satisfy the department's research requirement for the master's degree. Staff. May be taken for 3 cr. per semester in each of two semesters or 6 cr. in one semester. Maximum 6 cr.

## 895-896. READING AND RESEARCH IN PSYCHOLOGY

As part of the development as an independent scholar, the student is encouraged to plan: 1) broad reading in an area; 2) intensive investigation of a special problem; or 3) experimental testing of a particular question. The project may involve library research, empirical research, or both. Registration must be acceptable to the student's guidance committee and to the staff member who has agreed to serve as the adviser on the project. May be repeated. 1) Physiological, 2) Perception, 3) History and Theory, 4) Learning, 5) Social, 6) Cognition, 7) Statistics and Methodology, 8) Psychopathology, 9) Developmental. Staff. 3-6 cr. per semester.

## 897-898. PROBLEMS AND ISSUES IN PSYCHOLOGY

A seminar to be offered by one or more members of the staff, concerning problems and issues of special importance in the current development of the field. On occasion, the seminar will feature a problem which has been the subject of specialized research and study by a member of the staff. The personnel and topical focus will vary from year to year, and the course may be repeated by the student. Staff. 3 cr.

## 899. MASTER'S THESIS

Each student will carry out original research that culminates in a master's thesis. May be taken 3 cr. per semester in each of two semesters or 6 cr. in one semester. Maximum 6 cr.

## 999. DOCTORAL RESEARCH

## Graduate Courses Offered Primarily for Students Enrolled in Other Graduate Programs

### 822. THERAPEUTIC PSYCHOLOGY

The course will orient itself around the following three areas: issues which include various aspects of the human condition, essential ingredients in the therapeutic process and in therapy outcomes, effective qualities of therapists, and a full range of ethical considerations; involvement through participation in a group for the presentation of a particular therapeutic approach, comparison of two or more therapists or kinds of therapy, or application of therapeutic psychology to a particular problem area of institutional setting; integration of personal reading, participation in class discussions, and comparison of group presentations. 4 cr. (Offered only in the summer.)

### 823. INDIVIDUAL TESTING

Training in administration, scoring, and behavioral observation necessary for interpretation of individual tests of intelligence with discussion and demonstration of certain other instruments for cognitive measurement. The focus will be on children rather than adults, and on technique rather than interpretation. Each student will be required to purchase one set of materials. Prerequisite: permission of instructor. (Student's background in Statistics, Measurement, Exceptional Child, and Personality Theory will be evaluated by the instructor.) 1 lec/1 lab/4 cr. to be granted only after the student has passed the companion course, Psychology 825, Use of Individual Intelligence Tests.

### 824. PRACTICUM IN INDIVIDUAL INTELLIGENCE TESTING

Supervised experience in use of individual intelligence tests in elementary and junior high school settings. Prerequisites: Psychology 823 or equivalent, and permission of instructor. 2 cr. to be granted only after the student has passed Psychology 825, Use of Individual Intelligence Tests. Psychology 825 may be taken concurrently or subsequently.

### 825. USE OF INDIVIDUAL INTELLIGENCE TESTS

Interpretation and use of individual intelligence test results in relation to the cognitive functioning of the child within the school setting. Emphasis will be on taking into account background factors such as culture, emotional status, meaning of the test to the child, and on ethical and administrative problems connected with interpreting test results to parents and school personnel. Students will have an opportunity to discuss case material from their actual daily work. Prerequisites: Psychology 823, Psychology 824, which may be taken concurrently; permission of the instructor. 3 cr.

## Sociology (82)

**Chairman:** Richard E. Downs

**PROFESSORS:** Melvin T. Bobick, Walter Buckley, Richard S. Dewey, Stuart Palmer, Solomon Poll, Murray A. Straus

**ASSOCIATE PROFESSORS:** Thomas R. Burns, Peter Dodge, Richard E. Downs, Bud B. Khelif, Arnold S. Linsky, Fred Samuels, Howard M. Shapiro

**ASSISTANT PROFESSORS:** Loren Cobb, Stephen P. Reyna

**DIRECTOR OF GRADUATE STUDIES:** Thomas R. Burns

The Department of Sociology and Anthropology offers M.A. and Ph.D. degrees in Sociology. The master's degree program emphasizes theory and methodology. Students in the doctoral program are expected to select from the areas of departmental specialization one major area—and from the areas of expertise found among the faculty, one minor area—for intensive study and examination. There are four major substantive areas for possible specialization: deviance, conflict, and control; social psychology; comparative institutional analysis; family. In addition, students may propose to the graduate committee other major areas of specialization which fall within the faculty's competence.

Social Psychology is an interdisciplinary program operated in conjunction with the psychology department. Students are admitted by and meet the requirements of their respective departments. Their work in social psychology, however, is coordinated by an advisory committee with representatives from both departments and includes course work in both departments.

The student's proficiency in theory, statistics, and methods, and in the major and minor areas of study is determined by an examination composed of written and oral sections. Details about the examination can be found in the Graduate Student Handbook which is sent to all students requesting information about the program. Within the context of a curriculum organized largely in the form of seminars and research under the supervision of assigned faculty members, the student is expected to select from the departmental specializations one major area for intensive study, and also with the approval of the student's adviser and the Graduate Committee to design a minor area suited to his/her specific interests from the balance of the curriculum offered by the department—including anthropology courses. In addition, a student is expected to give evidence of satisfactory performance in an extra-departmental field that has been approved as appropriate to his/her professional development. The design of a program most suitable to the individual will take into consideration both the student's past experience and intellectual goals, and, given the guidelines sketched above, flexibility will be emphasized. The selection of thesis and dissertation topics is thus

limited only by the areas of expertise available among departmental faculty members.

Upon establishing residence the student will be responsible for remaining informed about any modifications in the requirements of the degree program in which he/she is enrolled.

To be awarded the Master of Arts degree the candidate must fulfill the following requirements: 1) Complete satisfactorily at least one full year (24 credit hours) of graduate-level course work in Sociology including Sociological Methods I and II (801 and 802) and Sociological Theory I or II (811 or 812). 2) Register for one credit of thesis work during the second semester of residence and submit a draft of a proposal to the thesis committee by the end of the semester. The proposal or an abstract must be circulated to all department faculty. 3) Submit for approval a report of an original research endeavor to the thesis committee. This report may be in the form of either a) a thesis, or b) a paper in the form outlined in the publication format of any major sociological journal.

To be awarded the Doctor of Philosophy degree the candidate must fulfill the residence requirement of three years' work after the bachelor's degree, including: 1) A minimum of 12 courses in Sociology, other than thesis or dissertation research, including Sociological Theory I and II (811 and 812); Sociological Methods I and II (801 and 802) and one other course in methods or statistics (which would normally be 803); three courses in a major area, and two in a minor area, of sociology. 2) A minor in a field other than Sociology, consisting of three related courses. 3) Pass an oral and written examination in the major and minor areas of sociological specialization and in advanced theory and methodology. 4) Demonstrate reading level proficiency in a foreign language or a research tool appropriate to the overall program of the student. If the research tool option is chosen, it must not be part of the other degree requirement for graduate students in sociology. Examples of such research tools include computer programming, symbolic logic, historiography, econometric techniques, and mathematical statistics. At the time they are admitted to the Ph.D. program, students must submit for approval by the Graduate Committee a statement indicating how they intend to meet the language/research tool requirement. 5) Fulfill the research and/or teaching requirement described below. 6) Write and defend an acceptable doctoral dissertation.

In planning the program of study the student will be advised at first by an assigned faculty member and, subsequently, in the case of doctoral students, by a guidance committee. Specially appointed committees will be organized for the direction and assessment of the thesis and dissertation. Under such supervision the student is expected to go considerably beyond the minimal common requirements of the graduate program to establish a knowledgeability and competency peculiarly his/her own, but the student will be permitted to take courses outside the department or below the 700-level within the

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department only with the express permission of the student's adviser.

Students are permitted to register for Reading and Research in Sociology and Anthropology (895, 896) to pursue their individual interests. Any and all course work, including required course work, may be satisfied through the directed study. Upon completion, work done under this rubric will be reported, in writing, to the Graduate Committee and the student's adviser by the faculty member who assumes the responsibility for supervising such activities specifying a) the area within which the work was done, and b) the general content of the course experience achieved by the student.

In all cases, a student having knowledge equivalent to any of the required courses may substitute an examination to be given by the faculty member responsible for the course.

An important part of the graduate program is the opportunity to learn from participation in the teaching and research activities of the department faculty. All candidates for doctoral degrees are therefore expected to assist a member of the department in teaching and/or research. Assignments to work with a specific member will be made by the Graduate Committee on the basis of the student's experience, the needed areas of training, and the interests and preferences expressed by the students and faculty members.

To be accepted as a graduate student in sociology, the applicant must present, in addition to meeting the general Graduate School requirements, Graduate Record Examination scores on the verbal and quantitative sections of the aptitude test and his/her score on the advanced test in sociology. Undergraduate majors in other fields may be admitted. However, if the student's undergraduate work has not included an introductory course in sociological theory, research methods, statistics, and two other sociology courses, these five courses must be taken—or equivalent knowledge demonstrated through examination—in addition to the requirements outlined above.

Ordinarily, students will be admitted in the expectation of their completing the entire graduate program. Well-qualified applicants for a terminal Master of Arts degree, and applicants who have initiated their graduate work in sociology at another institution, will, however, be given full consideration.

## 720. CURRENT DEVELOPMENTS IN SOCIOLOGY OF THE FAMILY

A current topic will be selected each semester, such as stratification and the family, intra-family communication, power structure of the family, kinship in modern societies. Critical review of the literature; class or individual research project will usually be carried out. Prerequisite: 8 credits of sociology, Soc. 520 recommended. 4 cr.

## 721. FAMILY INTERACTION

Influence of family interaction on human behavior. Self, interactionist, and role approach. Analysis of research. Prerequisite: 8 credits of sociology and/or psychology; Soc. 500 recommended. 4 cr.

## 735. COMPLEX ORGANIZATIONS

Comparative study of the structure and dynamics of complex, formal organizations (business, military, political and governmental, educational, medical). Power and social control in formal systems; organizational processes, performances, and effectiveness; impact of complex, formal organizations on persons and societies. Prerequisite: permission of instructor. 4 cr.

## 740. CULTURE CHANGE

Various types of society; development of theory. Descriptive studies of institutional as well as theoretical materials selected from the writing of Comte, Marx, Spencer, Durkheim, Spengler, Sorokin, Redfield, and others. Prerequisite: Soc. 400. 4 cr.

## 741. SOCIAL CHANGE AND SOCIETAL DEVELOPMENT

Comparative, interdisciplinary approach. Interrelationships among economic, political, and social factors in determining the structure, dynamics, character, and level of development of societies. Prerequisite: permission of instructor. Soc. 740 recommended. 4 cr.

## 745. SOCIAL STRATIFICATION

The pattern of distribution of economic, honorific, and political variables within the populations of complex societies; the allocation of personnel to the roles in question, notably through occupational mobility; and the impact of such processes upon behavior, both individual and social. Prerequisite: Soc. 400. 4 cr.

## 757. SOCIAL INSTITUTIONS OF LATIN AMERICA AND THE CARIBBEAN

Selected analysis of distinctive institutions and social systems, with particular attention to social aspects of the process of modernization. Prerequisite: permission of instructor. 4 cr.

## 761. POPULATION DYNAMICS

Major population trends including changes in birth and death rates, population characteristics, mobility, migration, world population growth, population problems, and policies of countries at different stages of economic development. Interrelationship of population and society. 4 cr.

## 770. CULTURE, PERSONALITY, AND SOCIETY

A cross-cultural view of the development of personality as emergent from genetic, situational, and sociocultural determinants; analysis of the dynamic interplay of sociocultural and psychological behavior systems. Prerequisite: any two courses from Soc. 400, Anthro. 411, and Psych. 401. 4 cr.

## 780. SOCIAL CONFLICT

The nature of social conflict, especially at war. The setting and initiation of conflict, its dynamics, and the factors affecting its course and outcome. Prerequisite: permission of instructor. 4 cr.

## 785. THE STUDY OF WORK

Understanding society through the structure of work. Case studies, in an ethnographic manner, of high-status and low-status occupations to provide understanding of social processes and interrelationships in the social structure. Prerequisite for graduate students: permission of instructor. 4 cr.

## 790. APPLIED SOCIOLOGY

1) Current level of use of sociological knowledge; 2) the advocate, consultant, and researcher roles in applied settings; 3) techniques of applied research; 4) implications of applied sociology, including ethical problems. Each student will focus on a social problem and write a paper covering the above issues. Applied projects where possible. Prerequisite: Soc. 601. 4 cr.

## 801. SOCIOLOGICAL METHODS I. INTERMEDIATE SOCIAL STATISTICS

Application of descriptive and inferential statistical methods to the analysis of sociological data, including sampling distributions, statistical decision-making, analysis of variance, correlation and regression, and nonparametric measures. Prerequisite: Sociology 601, Methods of Social Research, or permission of instructor. 4 cr.

## 802. SOCIOLOGICAL METHODS II. RESEARCH DESIGN

Systematic investigation of each step in the design and implementation of sociological research. Selected techniques of data collection and analyses will be pursued. Prerequisite: Sociology 601, Methods of Social Research and 602, Social Statistics, or their equivalent, or permission of instructor. 4 cr.

## 803. SOCIOLOGICAL METHODS III. SPECIAL PROBLEMS IN METHODS AND STATISTICS

Attention is focused on one or more special problems in sociological research, such as the following: measurement and scaling, field and laboratory experiments in sociology, multi-variate analysis, historical methods, community studies, mathematical models in sociological research, and survey design and analysis. Prerequisites: Sociology 801, and Sociology 802 or Psychology 809. 4 cr.

## 811. SOCIOLOGICAL THEORY I

The content, presuppositions, and implications of the body of sociological theory, exemplifying the full range of sociological inquiry. Prerequisites: Sociology 611, History of Social Theory, and 612, Contemporary Sociological Theory, or their equivalents. 4 cr.

## 812. SOCIOLOGICAL THEORY II

The content, presuppositions, and implications of contemporary sociological theory. The student will engage in theory construction and analysis, and in this endeavor will be encouraged to develop his/her particular interests in substantive areas. Prerequisite: Sociology 811. 4 cr.

## 813. SOCIOLOGICAL THEORY III

A seminar of intensive study of topics in sociological theory. Sample topics include: exchange theory, functionalism, systems theory, theory construction, pioneering theorists. Prerequisites: Soc. 611, History of Social Theory, and 612, Contemporary Sociological Theory, or their equivalents. 4 cr.

## 821. DEVIANT BEHAVIOR

A seminar in which attention is directed to the relationships among cultural, subcultural, and personality variables and deviant behavior. Special emphasis is placed on the following forms of deviant behavior: invention, crime, alcoholism, and emotional illness. Prerequisite: permission of instructor. 4 cr.

## 830. THE SMALL GROUP

The small group as a unit for sociological study, for the testing and the developing of hypotheses. Both the behavior and the attitudinal levels shall be considered with respect to group intra-action and group-to-group interaction. The effects of different independent variables upon group structures shall be of particular interest. Prerequisite: a course in social psychology, or permission of instructor. 4 cr.

## 838. SOCIOLOGY OF EDUCATION: SOCIAL ORGANIZATION OF SCHOOLS AND COMMUNITY

This course emphasizes viewing schools in their socio-cultural context; it is centered on a number of field studies of urban and suburban communities. Among the topics discussed are the following: a) Comparative institutional analysis—what is church-like, hospital-like, factory-like, and prison-like about the school; b) relations and perspectives of functionaries and clients in culturally deprived and culturally endowed settings; and c) teaching as an emergent profession. 4 cr. (Also offered as Education 838.)

## 850. METHODS OF SOCIAL PSYCHOLOGICAL ANALYSIS

An examination of the procedures, logic, inferential strength, and potential bias of the various methodologies for studying social behavior. Issues regularly introduced include experimental, quasi-experimental and non-experimental designs, the laboratory-field continuum, social psychological aspects of interviews and experiments, the nature of artifacts and their lethality, and other current methodological issues. The course emphasizes the design of social psychological research rather than statistical analysis, though statistical matters regularly arise. Graduate level sophistication in statistics is assumed. 4 cr. (Also offered as Psychology 850.)

## 851. SEMINAR IN SOCIAL PSYCHOLOGY

A seminar devoted to theoretical and experimental support for major topics of current concern. These may include attitude change, power, interpersonal perception and attraction, roles, interaction, and analysis of structure and function in complex social systems. Prerequisite: permission of instructor. 4 cr. (Also offered as Psychology 851.)

## 852. SOCIALIZATION AND ABNORMAL BEHAVIOR

A seminar concerned with socialization and the effects of socialization on abnormal behavior. A survey of those orientations that relate socialization to abnormal behavior with the aim of synthesizing the major concepts into current sociological and social-psychological frames of reference. In addition, emphasis will be placed on the methodological problems of research concerned with socialization. Prerequisite: at least one course in social psychology or permission of instructor. 4 cr.

## 854. SOCIOLOGY OF RELIGION

Critical analysis of the reciprocal relationship of religion and culture; the function of religion in society; the contributions of sociological research; the relationship between religion and other social institutions; religion and social change; and the problem of church and state. 4 cr.

## 861. DEMOGRAPHY

Survey and analysis of current problem areas in demography, including: fertility, mortality, migration, population growth, population theory, formal demography, and the use of demographic sources and techniques in sociological investigation. Prerequisite: Sociology 761 or permission of instructor. 4 cr.

## 870. COMPARATIVE INSTITUTIONAL ANALYSIS

Theoretical and methodological aspects of cross-national comparative research in sociology, including: history of comparative research, examination of differences in objectives and methods employed, problems of translation and conceptual equivalence of behaviors and indexes, and field techniques. Prerequisites: Sociology 601, Methods of Social Research, and 602, Social Statistics. 4 cr.

## 875. FAMILY AND BEHAVIOR PROBLEMS

Analysis of the approaches used in the sociological study of families. Emphasis on the distinct contributions and the overlaps among such approaches as social structure and socialization. Theoretical statements and empirical studies utilizing these approaches will be discussed. Specific focus will be directed to the use of various models, conceptualizations, etc., for research on families with behavior problems (broadly defined). Issues concerning familial etiology of the response to behavior problems as well as the family's transactions with the wider community will be dealt with in reference to particular types of problems. 4 cr.

## 885. OCCUPATIONS AND PROFESSIONS

Professionalization is discussed as adult socialization, an acquisition of a new identity; professions are explored as ideologies and as extended families. Low-status and high-status occupations are compared with regard to the way their members are recruited and trained, their career stages, work problems, and role-sets. A symbolic interactionist approach is adopted; issues of work are considered in their socio-cultural and institutional contexts; a number of the Chicago studies of occupations are examined. 4 cr.

## 888. SOCIOLOGY OF EDUCATION: THE CULTURES OF POVERTY AND AFFLUENCE

The two cultures are treated as a unit; culture change is discussed. Issues of current interest are explored, e.g., poverty, school desegregation, the schooling of geographically-mobile children, problems of social mobility and abundance, the rise of the counseling and healing trades, and teachers' quest for professionalism. The education of culturally deprived and culturally



endowed children receives special attention. A comparative approach is adopted; issues are examined cross-culturally and in relation to the schooling process. 4 cr. (Also offered as Education 888.)

## 889. SOCIOLOGY OF EDUCATION: RACE AND ETHNIC RELATIONS IN SCHOOLS AND SOCIETY

This course deals with ethnic stratification and inter-group processes both inside and outside the school. The public schooling of disadvantaged groups such as black, Indian, white Appalachian, and Mexican Americans, receives special attention. Caste and class relations between schoolmen, parents, and pupils are examined within such contexts as slums, reservations, Levittowns, and "golden ghettos." A socio-anthropological perspective is emphasized. 4 cr. (Also offered as Education 889.)

## 895, 896. READING AND RESEARCH IN SOCIOLOGY AND ANTHROPOLOGY

A student prepared by training and experience to do independent work under the guidance of an instructor may register for one or more of the following sections: 1) communications, 2) criminology, 3) cultural/social anthropology, 4) culture change, 5) culture and personality, 6) deviant behavior, 7) prehistoric archaeology, 8) family, 9) population, 10) rural-urban, 11) social control, 12) social differentiation, 13) social movements, 14) social psychology, 15) social research, 16) social theory, 17) anthropological linguistics, 18) social welfare. Prerequisites: 16 graduate hours of sociology and permission of instructor. Hours and credit to be arranged.

## 897, 898. SPECIAL TOPICS SEMINAR

Under the direction of members of the department on the basis of rotation and interest, seminars are offered in those fields listed under Sociology 895, 896. Prerequisite: permission of instructor. 4 cr.

## 899. MASTER'S THESIS

Usually 6 cr. but up to 10 cr. when the problem warrants.

## 999. DOCTORAL RESEARCH

## Anthropology (85)

### 731, 732. AREA STUDIES IN ARCHAEOLOGY

Offered as staff is available and student needs dictate. 1) South America: Begins with the earliest cultural remains and progresses up to the time of European contact; changing relationship of culture and environment. 2) Mesoamerica: Earliest cultural

remains, through Olmec, Maya, Toltec and Aztec; changing relationship of culture and environment. Prerequisite: Anthro. 412 and 514, or permission of instructor. 4 cr.

### 747 (747). AREA STUDIES IN SOCIAL AND CULTURAL ANTHROPOLOGY

1) South America, 2) Meso America, 3) North America, 4) Oceania, 5) Southeast Asia, 6) Africa, 7) Other. Offered as staff is available and the student needs dictate. Characteristic ecological, historical, and socio-cultural factors. Analysis of selected societies and institutions. Prerequisite: Anthro. 411 or permission of instructor. 4 cr.

### 752. SOCIAL PROBLEMS IN MODERN AFRICA

Problems of change and development in Africa considered from the anthropological perspective. Prerequisite: Anthro. 411 or permission of instructor. 4 cr.

### 775. ANTHROPOLOGICAL THEORY

Major theoretical approaches in historical perspective. Prerequisite: Anthro. 411 or permission of instructor. 4 cr.

## Spanish and Classics (77)

**Chairman:** John C. Rouman, Associate Professor of Classics

**PROFESSORS:** R. Alberto Casás, Charles H. Leighton

**ASSOCIATE PROFESSOR:** Richard J. Callan

**ASSISTANT PROFESSORS:** F. William Forbes, Assistant Chairman for Spanish, Lois Grossman

The Department of Spanish and Classics offers courses leading to two degrees in Spanish: the Master of Arts and the Master of Science for Teachers.

### Master of Arts

To be admitted to graduate study for the Master of Arts degree in Spanish, a student must have completed 30 credits in Spanish language and literature beyond first year Spanish including a survey of Spanish literature and two other literature courses. In addition, all candidates for admission must take the Graduate Record Examination Aptitude Test and Advanced Test in Spanish. To obtain the degree, the student must fulfill the course requirements, pass a comprehensive examination based on a master's degree reading list, and submit an acceptable thesis if such an option is chosen.

## Spanish and Classics

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To satisfy the course requirements, the student must: a) successfully complete 10 graduate courses (of which eight should be from the Spanish offerings); or, b) successfully complete at least eight courses in Spanish and submit a thesis (six credits, thus completing the minimum of 30 credits required by the Graduate School).

In addition, M.A. students are required to take 801. Teaching assistants must also take 803. No student may register for a graduate course if she/he has already taken the corresponding undergraduate course here or its equivalent elsewhere.

A comprehensive examination based on a master's degree reading list will be given four times a year; in January, May, August, and September. The candidate will be permitted to take the examination only twice. Students failing their first attempt must wait at least three months before taking it again. The thesis option must embody the results of independent investigation and be written in a form acceptable to the department. It must be submitted to the thesis director six weeks before expected time of degree conferral.

### Master of Science for Teachers

To be admitted to graduate study for the Master of Science for Teachers degree in Spanish, a candidate must have satisfactorily completed the requirements for secondary school teacher certification in the language. To obtain the degree, he must complete ten graduate courses of which eight will be from among Spanish offerings. Candidates must pass a department examination based on the master's degree reading list. Secondary school teachers interested in this degree should consult the Spanish section chairman.

### Spanish (77)

#### 801. BIBLIOGRAPHY AND METHODS OF RESEARCH

Required of all graduate students in their first year of study. An introduction to standard bibliographical techniques, to form and style in the preparation and writing of research findings. Preparation of a research paper. 1 cr.

#### 803. APPLIED LINGUISTICS

Required of all graduate assistants teaching in the departmental program, but open to all graduate students in Spanish. Discussion of current methodology and linguistic approaches to the teaching of Spanish. Instruction in the use of audio-visual aids, including language laboratories. Readings, discussion, class observation. 1 cr. May be repeated for a sum total of 3 cr.

#### 811. MEDIEVAL SPANISH LITERATURE

Study of a topic or topics in Spanish literature of the period 1100-1500. Works normally to be studied include Berceo, the

*Libro de buen amor*, the poetic schools of the 15th century, and *La Celestina*. Social and historical backgrounds of the period. Conducted in Spanish. 3 cr.

#### 831. RIVER PLATE LITERATURE

Sarmiento, Jose Hernandez, Rodo, Florencio Sanchez, Mallea. Focus on the question of *argentinidad*. Conducted in Spanish. 3 cr. (Not offered every year.)

#### 852. DRAMA AND POETRY OF THE SIGLO DE ORO

Social background of Baroque period. Representative plays of Lope de Vega, Tirso de Molina, Calderon; poetry of Lope, Gongora, and Quevedo. Prose development. Conducted in Spanish. 3 cr. (Not offered every year.)

#### 854. CERVANTES

Cervantes' literary art. Selections from the major works. The Quixote, its originality and significance; its antecedents; its religious, philosophical, and sociological aspects; and its artistic structure. Conducted in Spanish. 3 cr. (Not offered every year.)

#### 855. LITERATURE OF THE 19th CENTURY

Larra, Espronceda, Becquer, Perez Galdos, and Blasco Ibanez, in the artistic, philosophical, and social environment of the century. Conducted in Spanish. 3 cr. (Not offered every year.)

#### 857. THEATER AND POETRY OF THE 20th CENTURY

The Generation of 198; Benavente, Machado, J.R. Jimenez, Garcia Lorca, Casona, Sastre, Buero Vallejo, Damaso Alonso, and Miguel Hernandez. Conducted in Spanish. 3 cr. (Not offered every year.)

#### 858. SPANISH PROSE OF THE 20th CENTURY

Novels, short stories, and essays. Unamuno, Baroja, Menendez Pidal, Ortega y Gasset, Julian Marias, Aranguren, Perez de Ayala, Gironella, and Cela; survey of contemporary prose. Conducted in Spanish. 3 cr. (Not offered every year.)

#### 860. UNAMUNO AND ORTEGA Y GASSET

Philosophical ideology and literary content of major contributions of Miguel de Unamuno and Jose Ortega y Gasset. 3 cr. (Not offered every year.)

#### 871. SPANISH-AMERICAN DRAMA

From pre-Hispanic origins to the present; modern playwrights of Mexico and Puerto Rico. Conducted in Spanish. 3 cr. (Not offered every year.)

## 872. SPANISH-AMERICAN NOVEL

Development from Romanticism to present; contemporary trends and techniques. Conducted in Spanish. 3 cr. (Not offered every year.)

## 873. SPANISH-AMERICAN SHORT STORY

Representative authors; stress on 20th century. Principles of interpretation. Conducted in Spanish. 3 cr. (Not offered every year.)

## 874. MAJOR SPANISH-AMERICAN AUTHORS

Conducted in Spanish. 3 cr. (Not offered every year.)

## 891. METHODS OF FOREIGN LANGUAGE TEACHING—SPANISH

Interdepartmental course. Objectives, methods, and techniques in teaching Spanish, French, German, and Latin from elementary through college. Discussion, demonstration, preparation of instructional materials, micro-teaching of the language skills. Prerequisite: permission of instructor. 3 cr.

## 895-896. SPECIAL STUDIES IN SPANISH LANGUAGE AND LITERATURE

1) The history of the Spanish language, 2) Medieval Spanish literature, 3) Spanish literature of the Renaissance, 4) Spanish literature of the Golden Age, 5) Spanish literature of the 18th and 19th centuries, 6) Spanish literature of the 20th century (1898-1936), 7) Contemporary Spanish literature, 8) Spanish American literature of the 16th and 17th centuries, 9) Spanish American literature of the 18th and 19th centuries, 10) Spanish American literature of the 20th century, 11) Contemporary Spanish American literature, 12) Structural and applied linguistics, 13) Spanish Literary Criticism, 14) Spanish-American Essay, 15) Latin America, 16) Catalan, 17) Spanish-American Poetry, 18) Spanish Poetry, 19) Galdos, 20) Archetype Latin American Literature, 21) Special Teaching Problems, 22) Spanish Civilization and Culture, 23) Latin-American Civilization and Culture, 24) Borges, 25) Spanish Theater. Guided study with training in bibliography and organization of material. Topics selected by instructor and student in conference. Prerequisite: permission of major supervisor. Variable, 1-3 cr.

## 899. MASTER'S THESIS

6 cr.

## Zoology (84)

**Chairman:** Philip J. Sawyer

**PROFESSORS:** Arthur C. Borrer, Wilbur L. Bullock, Lorus J. Milne, Philip J. Sawyer, Emery F. Swan, Paul A. Wright

**ASSOCIATE PROFESSORS:** Robert A. Croker, John E. Foret, Frank K. Hoornbeek, Marcel E. Lavoie, John J. Sasner, Edward K. Tiltinghast

**ADJUNCT ASSOCIATE PROFESSOR:** Clarence Porter

**ASSISTANT PROFESSORS:** Edward N. Francq, James F. Haney, Larry G. Harris, Roderick M. Smith, E.H. Wheeler

The graduate program in Zoology is intended for the student who aspires to a professional career within or outside the area of college teaching and research. Degrees can be earned with emphasis in behavior, development, ecology (freshwater and marine), endocrinology, genetics, invertebrate zoology, mammalogy, biological oceanography, parasitology, and physiology.

To be admitted to graduate study in Zoology, a student ordinarily must have completed an undergraduate major in biology or zoology. A basic array of courses including general biology, development, general ecology, genetics, morphology, and physiology is normally required. Additionally, a background in chemistry through organic chemistry, a semester each of calculus and physics is necessary. Students who are deficient in any of these requirements may sometimes be admitted to graduate status, but may be required to remedy their deficiencies by taking courses which do not give graduate credit.

Each newly accepted graduate student will be interviewed during the second week of classes of the first semester. This interview will be conducted at a specified time by a committee composed of the student's temporary academic adviser plus two additional faculty members. The purpose of this committee is to advise the student in constructing a program of study and to correct such academic deficiencies as may exist. The committee will have available transcripts, letters of recommendation, and the results of the diagnostic exam described below. The committee will then enter its evaluation and recommendations in the student's permanent record.

All incoming graduate students will take a diagnostic exam before classes begin. This will include questions from the areas of behavior, biochemistry and physiology, development, ecology, evolution and systematics, genetics, morphology, parasitology, and general biology. No student is expected to do uniformly well in all areas, but rather a high level of competence is expected in those areas relevant to the student's particular program. Should the Interview Committee, on the basis of this exam, consider that a deficiency exists, this may be remedied either by a formal course or by an oral examination

# Zoology

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upon recommendation of the committee. Such oral examinations will be given during the week immediately following the spring vacation.

A candidate for the Master of Science degree in Zoology, in addition to the requirements mentioned above, will ordinarily complete a special problem (Zoology 895 or 896) or a thesis that is acceptable to his guidance committee.

All doctoral students must pass a written examination to certify their proficiency in one foreign language. Some fields of pursuit may require more languages and this need will be determined by the student's guidance committee.

After the successful completion of the language requirements and of all required courses, the student who wishes to be admitted to doctoral candidacy must demonstrate a broad basic knowledge of his/her major and minor fields in an oral qualifying examination, administered by the doctoral committee. In addition, the student must convince his/her proposed major professor and doctoral committee, in whatever way the committee finds acceptable, of his/her superior capacity to carry out basic research in biology. Normally, the student may accomplish this by presenting to the committee a research proposal in which the soundness, originality, and feasibility of the investigative ideas are clearly revealed, and which—when approved—should serve as the basis of the doctoral dissertation.

## **704. COMPARATIVE ENDOCRINOLOGY**

Endocrine organs; relationship to control of the internal environment, growth, development, and adaptation to the external environment. Prerequisite: vertebrate anatomy and physiology; organic chemistry. 4 cr.

## **706. GENETICS LABORATORY**

Experiments and demonstrations in classical, developmental, and population genetics and cytogenetics, using a wide range of organisms and techniques. Pre- or corequisite: Zoo. 604 or equivalent and permission of instructor. 2 cr.

## **(707). HUMAN GENETICS**

Inheritance patterns; gene and chromosome mutation rates and effects; linkage and gene frequency. Prerequisite: Zoo. 604 or equivalent or permission of the instructor. 4 cr.

## **711. NATURAL HISTORY OF COLD-BLOODED VERTEBRATES**

Classes of poikilothermic vertebrates; their habits, habitats, and life histories in eastern North America. Prerequisite: general zoology and Zoo. 518. 4 cr.

## **(712). MAMMALOLOGY**

Origins, diversification, reproduction, ecology, behavior of mammals. Identification of local forms. Prerequisites: Zoo. 412, 518. 4 cr.

## **(713). ANIMAL BEHAVIOR**

Individual and social behavior. The role of anatomy, physiology, ecology, and prior experience. Techniques and practical application. Prerequisite: one year of zoology. 4 cr.

## **715. NATURAL HISTORY OF MARINE INVERTEBRATES**

Field and laboratory course; inshore marine invertebrate metazoan animals of northern New England. Identification, classification, habitat preferences, and behavior. Work (collection and observation) constitutes a major part of the course. Some travel expense. Prerequisite: general zoology. Summer only. 4 cr.

## **717. GENERAL LIMNOLOGY**

Special relationships of freshwater organisms to the chemical, physical, and biological aspects of the aquatic environment. Factors regulating the distribution of organisms and primary and secondary productivity of lake habitats. Prerequisites: Biology 541 or equivalent. 4 cr.

## **719. FIELD LIMNOLOGY**

Freshwater ecology examined through laboratory exercises with freshwater habitats. Methods to study freshwater lakes; interpretation of data. Seminars and occasional Saturday field trips. Prerequisite: present or prior enrollment in Botany 717, Zoo. 717, or equivalent; and permission of instructor. 3 cr.

## **721. PARASITOLOGY**

Introduction to the more important parasites causing disease in man and animals. Living materials will be used as far as possible. Prerequisite: one year of zoology. 4 cr. (Alternate years: offered in 1976-77.)

## **723. CELL PHYSIOLOGY**

Principles of chemistry and physics applied to understanding cell structure and function. Metabolic reactions and their control in relation to cell organization; genesis and function of specialized cells. Prerequisite: organic chemistry. 4 cr.

## **724. MARINE PARASITOLOGY**

Diseases and parasites of marine fishes and shellfish; emphasis on the local estuarine environment. Prerequisite: one year of zoology. 4 cr. (Alternate years: offered in 1975-76.)

## 728. INVERTEBRATE EMBRYOLOGY

Principles of animal development including metamorphosis and regeneration. Representative invertebrate types. Prerequisite: Zoo. 618. 3 lec/1 lab/4 cr.

## 729. VERTEBRATE EMBRYOLOGY

Principles of animal development; metamorphosis, regeneration, and aging. Selected vertebrates. Prerequisites: Zoo. 518, 527, and 604. 3 lec/1 lab/4 cr.

## 730. HISTOLOGY AND MICROTECHNIC

Microscopic anatomy of vertebrate tissues and organs; introduction to routine techniques used in such studies. Prerequisite: Zoo. 508 or 518 or equivalent. 1-hr lec/6-hr lab/4 cr.

## 772. FISHERIES BIOLOGY

Information and techniques used by fisheries biologists. Emphasis on fish life history, ecology, and economics as related to management techniques. Prerequisite: Zoo. 711 or equivalent, and permission of instructor. 4 cr.

## 774. INTRODUCTION TO MARINE SCIENCE

Daily lectures; laboratory, and field work. Offered at the Isles of Shoals in cooperation with Cornell and the State University of New York. Summers only. Prerequisite: at least a full year of college biology. 5 cr.

## 795, 796. SPECIAL PROBLEMS IN ZOOLOGY

1) Biological Oceanography, 2) Ecology, 3) Endocrinology, 4) Evolution, 5) Developmental Biology, 6) Genetics, 7) Histology, 8) History of Zoology, 9) Invertebrate Zoology, 10) Physiology, 11) Vertebrate Zoology, 12) Zoogeography, 13) Zoological Techniques, 14) Parasitology, 15) Histochemistry, 16) Protozoology, 17) Systematics, 18) Animal Behavior, 19) Teaching Practices. May elect one or more sections for advanced study. Reading, laboratory work, organized seminars, and/or conferences. Prerequisite: permission of staff required. (Limit of 12 credits from the sections of this course.) 2 or 4 cr.

## (803). MARINE ECOLOGY

The marine environment and its biota, emphasizing intertidal and estuarine habitats. Lecture, field and laboratory, discussions, and independent research project. Mr. Croker. Prerequisites: Biology 541, and permission of instructor; courses in marine invertebrate zoology, oceanography, and statistics are desirable. 4 cr.

## (806). BIOLOGICAL OCEANOGRAPHY

The ocean as an environment for life; populations, their interrelationships, their adaptations to an oceanic existence. Prerequisite: permission of instructor. 4 cr. (Not offered every year; offered 1976-77.)

## 811. FRESHWATER ZOOPLANKTON ECOLOGY

Lectures and laboratory exercises on the methods of sampling zooplankton populations, factors regulating their temporal and spatial distribution, trophic interactions of planktonic communities, and role of zooplankton in nutrient cycle of lakes. Field trips will examine the zooplankton communities in varied freshwater habitats. Seminars cover current research papers in the field. Prerequisite: General Ecology and Limnology, Zoology 707, or equivalent and permission of instructor. 4 cr.

## 815. POPULATION ECOLOGY

Evolution, genetic theory, differentiation, and functioning of animal populations. Prerequisite: permission of instructor. 4 cr. (Not offered every year; offered 1975-76.)

## 817. ZOOPLANKTON

Oceanic and estuarine populations of zooplankton: their zoogeography, interrelationships, and adaptations to pelagic life. Prerequisites: Invertebrate Zoology and instructor's permission. 4 cr. (Not offered every year; offered 1977-78.)

## (820), (821). ADVANCED INVERTEBRATE ZOOLOGY

A detailed and comprehensive study of the morphology, phylogeny, and natural history of the major invertebrate phyla in lecture and laboratory. Prerequisite: Zoology 618, Introduction to Invertebrate Zoology, or equivalent. 4 cr.

## (822). PROTOZOOLOGY

The general biology of Protozoa, with particular emphasis on morphology, natural history, and economic importance. Mr. Borror. Prerequisite: Zoology 721 or 820 or permission of instructor. 4 cr.

## 826. COMPARATIVE PHYSIOLOGY

The means whereby animals, chiefly invertebrate, have met the problems of irritability, nutrition, maintenance of a constant internal environment, and reproduction. Mr. Sasner. Prerequisite: Zoology 723, and instructor's permission. 4 cr.

# Zoology

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## **828. EXPERIMENTAL EMBRYOLOGY**

An examination of cellular differentiation during development. Laboratories will illustrate techniques in experimental morphogenesis. Mr. Foret. Prerequisite: Zoology 728 or 729 or equivalent. 4 cr.

## **895, 896. ADVANCED STUDIES IN ZOOLOGY**

The sections of this course provide opportunity for advanced work either on an individual or group seminar basis. They may involve reading, laboratory work, organized seminars, and conferences. Prerequisite: permission of department chairman and staff concerned. (Sections of this course are the same as those listed under Zoology 795, 796). 2 or 4 cr.

## **897, 898. ZOOLOGY SEMINAR**

Preparation, presentation, and discussion of reports of recent zoological literature. Subject matter fields are the same as those listed under Zoology 795, 796. Not all areas will be available every semester. Required of graduate students in zoology. Staff. No cr.

## **899. MASTER'S THESIS**

Open to students who wish to do independent, original research. Prerequisite: permission of department chairman and prospective supervisor. 6 cr.

## **999. DOCTORAL RESEARCH**

Open to students who have declared their intention of proceeding to candidacy for the Doctor of Philosophy degree.

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**Donald E. Vincent, Ph.D.**  
University Librarian

**Andrew T. Mooradian, M.S.**  
Director of the Department of  
Intercollegiate Athletics

**Eugene A. Savage, M.Ed.**  
Director of Admissions

**Leslie C. Turner, M.Ed.**  
Registrar

**C. Robert Keesey, B.A.**  
Ombudsman

## Committees of the Graduate School

### Graduate Council

**Eugene S. Mills, Ph.D.**

President of the University

**Raymond L. Erickson, Ph.D.**

Dean of the Graduate School,  
Chairman

**William H. Drew, Ph.D.**

Associate Dean of the Graduate School

**Franz E. Anderson, Ph.D.**

Associate Professor of Geology

**Richard A. Andrews, Ph.D.**

Professor of Resource Economics

**William H. Annis, Ed.D.**

Professor of Occupational Education

**Peter Dodge, Ph.D.**

Associate Professor of Sociology

**Albert D. Frost, Sc.D.**

Professor of Electrical Engineering

**Galen E. Jones, Ph.D.**

Professor of Microbiology

**William R. Jones, Ph.D.**

Professor of History

**Kenneth J. Rothwell, Ph.D.**

Professor of Economics

**Samuel D. Shore, Ph.D.**

Associate Professor of Mathematics

**Jack R. Vrooman, Ph.D.**

Associate Professor of French

**Karen Andresen, B.A.**

Graduate Student, History

**Marinel Hartogensis, B.A.**

Graduate Student, Education

**Thomas Scott Shoupe, B.A.**

Graduate Student, Chemistry

**Kenneth O. Freer, M.Phil.**

Secretary to the Council and  
Assistant to the Dean

### Research Council

**Raymond L. Erickson, Ph.D.**

Director of Research

**John A. Lockwood, Ph.D.**

Acting Associate Director of Research

**Katherine Amsden, Ph.D.**

Associate Professor of Physical Education

**Kenneth K. Andersen, Ph.D.**

Professor of Chemistry

**John A. Beckett, M.B.A.**

Forbes Professor of Management

**William R. Chesbro, Ph.D.**

Professor of Microbiology

**Peter S. Fernald, Ph.D.**

Associate Professor of Psychology

**Filson H. Glanz, Ph.D.**

Associate Professor of Electrical  
Engineering

**Donald H. Graves, Ph.D.**

Assistant Professor of Education

**Yun Tzu Kiang, Ph.D.**

Assistant Professor of Plant Sciences  
and Genetics

**Douglas E. Morris, Ph.D.**

Assistant Professor of Resource Economics

**Susan Schibanoff, Ph.D.**

Assistant Professor of English

**William Lentharth, B.S.**

Graduate Student, Mechanical Engineering

**Donald R. Thurston, B.A.**

Graduate Student, INER

### Faculty Fellowship Selection Committee

**Walter M. Collins, Ph.D.**

Professor of Animal Science and Genetics

**Alfred G. Forsyth, Ph.D.**

Associate Professor of Psychology

**Albert D. Frost, Ph.D.**

Professor of Electrical Engineering

**Herman Gadon, Ph.D.**

Professor of Business Administration

**Walter E. Weiland, Ph.D.**

Associate Professor of Physical Education

### Student Fellowship Selection Committee

**Charles W. Owens, Ph.D.**

Associate Professor of Chemistry

**Douglas G. Routley, Ph.D.**

Professor of Plant Science

**Ronald E. Shor, Ph.D.**

Associate Professor of Psychology

**Gail D. Ulrich, Sc.D.**

Assistant Professor of Chemical Engineering

**Dwayne Wrightsman, Ph.D.**

Associate Professor of Finance

### Tuition Scholarship Selection Committee

**Margaret D. Ackerman, Ph.D.**

Assistant Professor of Education

**Phyllis Hoff, Ph.D.**

Associate Professor of Physical Education

**Fred R. Kaen, Ph.D.**

Assistant Professor of Finance

**David E. Limbert, Ph.D.**

Assistant Professor of Mechanical  
Engineering

**William W. Mautz, Ph.D.**

Assistant Professor of Wildlife Ecology



# Faculty of the Graduate School

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**Abend, Norman A.**

Adjunct Associate Professor of Civil Engineering; M.S., Cornell University, 1967; appointed 1974.

**Ackerman, Margaret D.**

Assistant Professor of Education; Ph.D., University of Pennsylvania, 1971; appointed 1971.

**Adams, W. Thomas**

Assistant Professor of Forest Resources; Ph.D., University of California, 1974; appointed 1974.

**Allen, Fred E.**

Professor of Animal Sciences, Veterinarian; D.V.M., Ohio State University, 1936; appointed 1940.

**Allmendinger, E. Eugene**

Associate Professor of Naval Architecture; M.S., University of New Hampshire, 1950; appointed 1958.

**Amell, Alexander R.**

Professor of Chemistry; Ph.D., University of Wisconsin, 1950; appointed 1955.

**Amsden, Katherine**

Associate Professor of Physical Education; Ph.D., University of Southern California, 1967; appointed 1967.

**Andersen, Kenneth K.**

Professor of Chemistry; Ph.D., University of Minnesota, 1959; appointed 1960.

**Anderson, Franz E.**

Associate Professor of Geology; Ph.D., University of Washington, 1967; appointed 1967.

**Andrew, Michael D.**

Associate Professor of Education; Ed.D., Harvard University, 1969; appointed 1966.

**Andrews, Richard A.**

Professor of Resource Economics; Ph.D., University of Minnesota, 1959; appointed 1959.

**Annis, William H.**

Professor of Occupational Education; Ed.D., Cornell University, 1961; appointed 1962.

**Antosiewicz, Rose T.**

Assistant Professor of Italian; Ph.D., University of California at Los Angeles, 1971; appointed 1970.

**Arnoldy, Roger L.**

Associate Professor of Physics; Ph.D., University of Minnesota, 1962; appointed 1967.

**Ashley, Charles H.**

Associate Professor of Education; Ed.D., Boston University, 1969; appointed 1969.

**Azzi, Victor D.**

Professor of Mechanics; D.Eng., Yale University, 1961; appointed 1965.

**Balling, L.C.**

Associate Professor of Physics; Ph.D., Harvard University, 1965; appointed 1967.

**Balomenos, Richard H.**

Professor of Mathematics Education; Ed.D., Harvard University, 1961; appointed 1961.

**Barlow, Robert F.**

Professor of Economics and Administration; Ph.D., Fletcher School of Law and Diplomacy, Tufts University, 1960; appointed 1962.

**Barrett, James P.**

Professor of Forest Biometrics and Genetics; Ph.D., Duke University, 1962; appointed 1967.

**Batchelder, Gerald M.**

Thompson School Associate Professor of Civil Technology and Adjunct Associate Professor of Civil Engineering; M.S.C.E., Purdue University, 1952; appointed 1953.

**Batho, Edward H.**

Professor of Mathematics; Ph.D., University of Wisconsin, 1955; appointed 1960.

**Beasley, Wayne M.**

Associate Professor of Materials Science; S.M., Massachusetts Institute of Technology, 1965; appointed 1957.

**Bechtell, Homer F., Jr.**

Associate Professor of Mathematics; Ph.D., University of Wisconsin, 1963; appointed 1966.

**Beckett, John A.**

Forbes Professor of Management; M.B.A., Harvard University, 1946; C.P.A.; appointed 1962.

**Bennett, Albert B.**

Associate Professor of Mathematics; Ed.D., University of Michigan, 1966; appointed 1967.

**Bereit, Virginia F.**

Assistant Professor of Education; Ed.D., Columbia University, 1971; appointed 1973.

**Bergeron, Richard D.**

Assistant Professor of Computer Science; Ph.D., Brown University, 1973; appointed 1974.

**Bertsch, Gregory J.**

Assistant Professor of Psychology; Ph.D., University of Vermont, 1970; appointed 1970.

**Betz, George W.**

Associate Professor of Economic Development; Ph.D., University of Wisconsin, 1966; appointed 1970.

**Birch, Francis S.**

Assistant Professor of Earth Sciences; Ph.D., Princeton University, 1969; appointed 1972.

**Bishop, Paul L.**

Assistant Professor of Civil Engineering; Ph.D., Purdue University, 1972; appointed 1971.

**Blanchard, Fletcher A., Jr.**

Professor of Electrical Engineering; M.S., Lehigh University, 1950; appointed 1950.

**Blanchard, Robert O.**

Assistant Professor of Plant Pathology; Ph.D., University of Georgia, 1971; appointed 1972.

**Blickle, Robert L.**

Professor of Entomology; Ph.D., Ohio State University, 1942; appointed 1938-41, 1946.

**Bobick, Melvin T.**

Professor of Sociology; Ph.D., University of Illinois, 1958; appointed 1958.

**Bogle, Alfred Linn**

Associate Professor of Botany; Ph.D., University of Minnesota, 1968; appointed 1970.

**Bonnice, William E.**

Associate Professor of Mathematics; Ph.D., University of Washington, 1962; appointed 1962.

**Borror, Arthur C.**

Professor of Zoology; Ph.D., Florida State University, 1961; appointed 1961.

**Bothner, Wallace A.**

Associate Professor of Geology; Ph.D., University of Wyoming, 1967; appointed 1967.

**Bowman, James S.**

Assistant Professor of Entomology; Ph.D., University of Wisconsin, 1958; appointed 1971.

**Bowring, James R.**

Professor of Resource Economics; Ph.D., Iowa State University, 1944; appointed 1948.

**Boy, Angelo V.**

Professor of Education; Ed.D., Boston University, 1960; appointed 1965.

**Boynton, Jason E.**

Associate Professor of Education; M.Ed., University of New Hampshire, 1952; appointed 1966.

**Braff, Allan J.**

Associate Professor of Economics and Business Administration; Ph.D., University of Wisconsin, 1959; appointed 1965.

**Briden, Earl F.**

Assistant Professor of English; Ph.D., Brown University, 1970; appointed 1970.

**Broderick, Dale G.**

Associate Professor of Business Administration; Ph.D., Columbia University, 1973; appointed 1974.

**Brown, Roger S.**

Assistant Professor of German; Ph.D., University of Kansas, 1971; appointed 1974.

**Brown, Wendell S.**

Assistant Professor of Earth Sciences; Ph.D., Massachusetts Institute of Technology, 1971; appointed 1974.

**Bruns, Paul E.**

Professor of Forest Resources; Ph.D., University of Washington, 1956; appointed 1958.

**Buckley, Walter F.**

Professor of Sociology; Ph.D., University of Wisconsin, 1958; appointed 1971.

**Bullock, Wilbur L.**

Professor of Zoology; Ph.D., University of Illinois, 1948; appointed 1948.

**Burns, Thomas R.**

Associate Professor of Sociology; Ph.D., Stanford University, 1969; appointed 1968.

**Burt, John**

Assistant Professor of Business Administration; Ph.D., Carnegie-Mellon University, 1969; appointed 1974.

**Burton, David M.**

Associate Professor of Mathematics; Ph.D., University of Rochester, 1961; appointed 1959.

**Byers, Gordon L.**

Professor of Soil and Water Science; M.S.A., Ontario Agricultural College, 1950; appointed 1956.

**Caldwell, S. Anthony**

Assistant Professor of English; Ph.D., Harvard University, 1968; appointed 1957.

**Callan, Richard J.**

Associate Professor of Spanish; Ph.D., St. Louis University, 1965; appointed 1969.

**Cannon, Michael R.**

Assistant Professor of Electrical Engineering; Ph.D., Rensselaer Polytechnic Institute, 1970; appointed 1974.

**Canon, Lance K.**

Associate Professor of Psychology; Ph.D., Stanford University, 1965; appointed 1973.

**Carney, John J.**

Assistant Professor of Education; Ph.D., Syracuse University, 1973; appointed 1973.

**Carnicelli, Thomas A.**

Associate Professor of English; Ph.D., Harvard University, 1966; appointed 1967.

**Carroll, John E.**

Assistant Professor of Environmental Conservation; Ph.D., Michigan State University, 1974; appointed 1974.

**Carter, Gavin H.**

Associate Professor of Physical Education; Ph.D., University of Oregon, 1958; appointed 1965.

**Casás, R. Alberto**

Professor of Spanish; Ph.D., Columbia University, 1954; appointed 1952.

**Celikkol, Barbaros**

Assistant Professor of Mechanical Engineering; Ph.D., University of New Hampshire, 1972; appointed 1969.

**Chaltas, John G.**

Associate Professor of Education; Ed.D., Columbia University, 1957; appointed 1967.

**Chasteen, N. Dennis**

Assistant Professor of Chemistry; Ph.D., University of Illinois, 1969; appointed 1972.

**Chesbro, William R.**

Professor of Microbiology; Ph.D., Illinois Institute of Technology, 1959; appointed 1959.

**Chupp, Edward L.**

Professor of Physics; Ph.D., University of California, 1954; appointed 1962.

**Cimbolic, Peter**

Adjunct Assistant Professor of Education; Ph.D., University of Missouri, 1970; appointed 1970.

**Clark, Charles E.**

Associate Professor of History; Ph.D., Brown University, 1966; appointed 1967.

**Clark, David G.**

Associate Professor of Physics; Ph.D., Pennsylvania State College, 1947; appointed 1947.

**Clark, Ronald R.**

Associate Professor of Electrical Engineering; Ph.D., Syracuse University, 1963; appointed 1957.

**Clee, Jan E.**

Dean of the Whittemore School of Business and Economics and Professor of Organizational Behavior; Ph.D., Case Institute, 1967; appointed 1967.

**Cobb, Loren**

Assistant Professor of Sociology; Ph.D., Cornell University, 1973; appointed 1972.

**Cohen, Allan R.**

Associate Professor of Business Administration; D.B.A., Harvard Graduate School of Business Administration, 1967; appointed 1967.

**Cole, Lawrence P.**

Associate Dean of the Whittemore School of Business and Economics and Assistant Professor of Economics; Ph.D., Purdue University, 1969; appointed 1966.

**Collins, Walter M.**

Professor of Animal Science and Genetics; Ph.D., Iowa State University, 1960; appointed 1951.

**Congdon, Robert G.**

Adjunct Professor of Psychology; Ed.D., Harvard University, 1961; appointed 1952.

**Copeland, Arthur H., Jr.**

Professor of Mathematics; Ph.D., Massachusetts Institute of Technology, 1954; appointed 1968.

**Corbett, Alan C.**

Associate Professor of Animal Science; D.V.M., Michigan State College, 1940; appointed 1941.

**Corcoran, Ellen P.**

Assistant Professor of Education; Ph.D., New York University, 1972; appointed 1972.

**Corell, Robert W.**

Professor of Mechanical Engineering; Ph.D., Case Institute of Technology, 1964; appointed 1964.

**Craig, Robert E.**

Assistant Professor of Political Science; Ph.D., University of North Carolina, 1971; appointed 1966.

**Croker, Robert A.**

Associate Professor of Zoology; Ph.D., Emory University, 1966; appointed 1966.

**Crowson, Lydia L.**

Assistant Professor of French; Ph.D., University of Wisconsin, 1972; appointed 1972.

**Curcio, Ronald P.**

Assistant Professor of Education; Ed.D., Rutgers University, 1969; appointed 1968.

**Daggett, Albert F.**

Professor of Chemistry; Ph.D., Columbia University, 1934; appointed 1928-31, 1935.

**Davis, James R.**

Assistant Professor of Psychology; Ph.D., University of Wisconsin, 1969; appointed 1970.

**Davis, Richard S.**

Dean of the College of Technology and Professor of Materials Science; Ph.D., University of Toronto, 1954; appointed 1968.

**Davis, Robert M.**

Assistant Professor of French; Ph.D., University of Wisconsin, 1972; appointed 1969.

**Dawson, Carl**

Associate Professor of English; Ph.D., Columbia University, 1966; appointed 1970.

**Dawson, Charles O.**

Professor of Civil Engineering; M.S., Ohio State University, 1940; appointed 1930.

**Dawson, John F.**

Associate Professor of Physics; Ph.D., Stanford University, 1963; appointed 1968.

**Deporte, Michael V.**

Associate Professor of English; Ph.D., Stanford University, 1966; appointed 1972.

**Desrosiers, Richard V.**

Assistant Professor of Classics; Ph.D., University of North Carolina, 1969; appointed 1965.

**Deville, Phillipe**

Assistant Professor of Economics; Ph.D., Stanford University, 1973; appointed 1973.

**DeVoto, Mark B.**

Associate Professor of Music; Ph.D., Princeton University, 1967; appointed 1968.

**Dewey, Richard S.**

Professor of Sociology; Ph.D., University of Wisconsin, 1941; appointed 1958.

**Diller, Ann L.**

Assistant Professor of Education; Ed.D., Harvard University, 1971; appointed 1973.

**Diller, Karl C.**

Associate Professor of English; Ph.D., Harvard University, 1967; appointed 1972.

**Dishman, Robert B.**

Professor of Political Science; Ph.D., Princeton University, 1948; appointed 1951.

**Dodge, Peter**

Associate Professor of Sociology; Ph.D., Harvard University, 1961; appointed 1964.

**Downs, Richard E.**

Associate Professor of Anthropology; Ph.D., University of Leiden, 1956; appointed 1962.

**Draves, David D.**

Associate Professor of Education; Ph.D., University of Wisconsin, 1957; appointed 1964.

**Drew, William H.**

Associate Dean of the Graduate School and Professor of Resource Economics; Ph.D., Vanderbilt University, 1961; appointed 1956.

**Dunlop, William R.**

Professor of Animal Science; D.V.M., V.S., Ontario Veterinary College, 1938; appointed 1950.

**Dunn, Gerald M.**

Professor of Plant Science and Genetics; Ph.D., Purdue University, 1951; appointed 1951.

**Durgin, Owen B.**

Associate Professor of Resource Economics; M.A., University of New Hampshire, 1951; appointed 1950.

**Durnall, Edward J.**

Director of the Division of Continuing Education and Associate Professor of Education; Ed.D., Oregon State University, 1953; appointed 1966.

**Dyken, James W.**

Adjunct Professor of Social Psychiatry; M.D., University of Vermont, 1945; appointed 1972.

**Eder, Sidney C.**

Assistant Professor of Education; Ph.D., Arizona State University, 1971; appointed 1971.

**Edwards, John C.**

Associate Professor of Speech and Drama; Ph.D., Northwestern University, 1963; appointed 1961.

**Ellis, David W.**

Vice Provost for Academic Affairs and Associate Professor of Chemistry; Ph.D., Massachusetts Institute of Technology, 1962; appointed 1962.

**Erickson, Raymond L.**

Dean of the Graduate School, Director of Research, and Professor of Psychology; Ph.D., University of California at Los Angeles, 1962; appointed 1963.

**Estes, George O.**

Associate Professor of Plant Science; Ph.D., Oregon State University, 1969; appointed 1969.

**Evans, Rand B.**

Associate Professor of Psychology; Ph.D., University of Texas, 1967; appointed 1972.

**Fairchild, Thomas P.**

Associate Professor of Animal Science and Genetics; Ph.D., University of Wisconsin, 1964; appointed 1969.

**Fan, Stephen S.T.**

Associate Professor of Chemical Engineering; Ph.D., Stanford University, 1962; appointed 1962.

**Farnsworth, Kirk E.**

Adjunct Associate Professor of Psychology; Ph.D., Iowa State University, 1968; appointed 1968.

**Federer, C. Anthony**

Adjunct Associate Professor of Micrometeorology; Ph.D., University of Wisconsin, 1964; appointed 1970.

**Feld, Sidney E.**

Assistant Professor of Resource Economics; Ph.D., University of Rhode Island, 1969; appointed 1974.

**Fernald, Peter S.**

Associate Professor of Psychology; Ph.D., Purdue University, 1963; appointed 1966.

**Fink, Stephen L.**

Professor of Organizational Development; Ph.D., Western Reserve University, 1959; appointed 1969.

**Fisher, G. Thomas**

Associate Professor of Entomology; Ph.D., Rutgers University, 1954; appointed 1969.

**Forbes, F. William**

Assistant Professor of Spanish; Ph.D., University of Arizona, 1971; appointed 1970.

**Foret, John E.**

Associate Professor of Zoology; Ph.D., Princeton University, 1966; appointed 1967.

**Forsyth, G. Alfred**

Associate Professor of Psychology; Ph.D., Purdue University, 1967; appointed 1967.

**Fort, Marron C.**

Associate Professor of German; Ph.D., University of Pennsylvania, 1965; appointed 1969.

**Foster, Bennet B.**

Associate Professor of Forest Resources; Ph.D., Duke University, 1966; appointed 1964.

**Fox, Leslie A.**

Assistant Professor of Psychology; Ph.D., University of Washington, 1968; appointed 1968.

**Francq, Edward N.**

Assistant Professor of Zoology; Ph.D., Pennsylvania State University, 1967; appointed 1965.

**Frick, George E.**

Adjunct Professor of Resource Economics; M.S., University of Connecticut, 1947; appointed 1957.

**Frost, Albert D.**

Professor of Electrical Engineering; Sc.D., Massachusetts Institute of Technology, 1952; appointed 1957.

**Gadon, Herman**

Professor of Business Administration; Ph.D., Massachusetts Institute of Technology, 1953; appointed 1964.

**Garrett, Peter W.**

Adjunct Assistant Professor of Forest Genetics; Ph.D., University of Michigan, 1969; appointed 1970.

**Gaudette, Henri E.**

Associate Professor of Geology; Ph.D., University of Illinois, 1963; appointed 1965.

**Geeslin, William E.**

Assistant Professor of Mathematics; Ph.D., Stanford University, 1972; appointed 1972.

**Gerhard, Glen C.**

Associate Professor of Electrical Engineering; Ph.D., Ohio State University, 1963; appointed 1967.

**Gilman, Paul A.**

Thompson School Professor of Civil Technology; M.S., Pennsylvania State University, 1951; appointed 1945.

**Gilmore, Robert C.**

Associate Professor of History; Ph.D., Yale University, 1954; appointed 1952.

**Glanz, Filson H.**

Associate Professor of Electrical Engineering; Ph.D., Stanford University, 1965; appointed 1965.

**Goffe, Lewis C.**

Associate Professor of English; Ph.D., Boston University, 1961; appointed 1946.

**Gordon, Bernard K.**

Professor of Political Science; Ph.D., University of Chicago, 1959; appointed 1971.

**Grant, Clarence L.**

Professor of Chemistry; Ph.D., Rutgers University, 1960; appointed 1952-58, 1961.

**Graves, Donald H.**

Assistant Professor of Education; Ph.D., State University of Buffalo, 1973; appointed 1973.

**Green, D. MacDonald**

Professor of Biochemistry and Genetics; Ph.D., University of Rochester, 1958; appointed 1967.

**Greenleaf, William**

Professor of History; Ph.D., Columbia University, 1955; appointed 1958.

**Grishman, Alan**

Associate Professor of Music, M.A., New York University, 1967; appointed 1967.

**Grossman, Lois S.**

Assistant Professor of Spanish; Ph.D., Rutgers University, 1972; appointed 1972.

**Haendler, Helmut M.**

Professor of Chemistry; Ph.D., University of Washington, 1940; appointed 1945.

**Hageman, Elizabeth H.**

Assistant Professor of English; Ph.D., University of North Carolina, 1971; appointed 1971.

**Hagstrom, Earl C.**

Associate Professor of Psychology; Ph.D., Brown University, 1957; appointed 1965.

**Hall, Francis R.**

Professor of Hydrology; Ph.D., Stanford University, 1961; appointed 1964.

**Haney, James F.**

Assistant Professor of Zoology; Ph.D., University of Toronto, 1970; appointed 1972.

**Hansen, Larry J.**

Assistant Professor of Home Economics; Ph.D., Florida State University, 1973; appointed 1973.

**Hapgood, Robert**

Professor of English; Ph.D., University of California, 1955; appointed 1965.

**Harris, Larry G.**

Assistant Professor of Zoology; Ph.D., University of California, 1970; appointed 1969.

**Harter, Robert D.**

Assistant Professor of Soil Chemistry; Ph.D., Purdue University, 1966; appointed 1969.

**Haslerud, George M.**

Professor of Psychology; Ph.D., University of Minnesota, 1934; appointed 1945.

**Haugstad, May Biggs**

Assistant Professor of Botany; Ph.D., The Catholic University of America, 1971; appointed 1969.

**Hebert, David J.**

Associate Professor of Education; Ph.D., Kent State University, 1967; appointed 1967.

**Heckel, Maynard C.**

Dean of the School of Continuing Studies and Professor of Adult Education; Ed.D., Cornell University, 1961; appointed 1971.

**Heilbronner, Hans**

Professor of History; Ph.D., University of Michigan, 1954; appointed 1954.

**Held, Warren H., Jr.**

Professor of Classics; Ph.D., Yale University, 1955; appointed 1967.

**Henry, William F.**

Professor of Resource Economics; M.S., University of Connecticut, 1942; appointed 1952.

**Herbst, Edward J.**

Professor of Biochemistry; Ph.D., University of Wisconsin, 1949; appointed 1962.

**Herr, Guenther K.W.**

Assistant Professor of German; Ph.D., University of Texas, 1966; appointed 1968.

**Hill, John L.**

Professor of Wood Science and Technology; D.F., Yale University, 1954; appointed 1964.

**Hochgraf, Frederick G.**

Associate Professor of Materials Science; M.S., Cornell University, 1958; appointed 1958.

**Hocker, Harold W., Jr.**

Professor of Forest Resources and Genetics; D.F., Duke University, 1955; appointed 1955.

**Hoff, Phyllis**

Associate Professor of Physical Education; Ph.D., University of Southern California, 1967; appointed 1967.

**Hodgdon, Albion R.**

Professor of Botany; Ph.D., Harvard University, 1936; appointed 1930-32, 1936.

**Hogan, John A.**

Carter Professor of Economics; Ph.D., Harvard University, 1952; appointed 1947.

**Holder, Mary E.**

Associate Professor of Home Economics; M.S., Michigan State University, 1949; appointed 1967.

**Holter, James B.**

Associate Professor of Animal Science; Ph.D., Pennsylvania State University, 1962; appointed 1963.

**Hoornbeek, Frank K.**

Associate Professor of Zoology and Genetics; Ph.D., Oregon State University, 1964; appointed 1964.

**Horrigan, James O.**

Professor of Business Administration; Ph.D., University of Chicago, 1967; appointed 1966.

**Hosek, William R.**

Associate Professor of Economics; Ph.D., University of California at Santa Barbara, 1967; appointed 1967.

**Houston, Robert E., Jr.**

Professor of Physics; Ph.D., Pennsylvania State University, 1957; appointed 1957.

**Howard, Cleveland L.**

Associate Professor of Music; D.M.A., Boston University, 1969; appointed 1969.

**Hoyle, Merrill C.**

Adjunct Assistant Professor of Plant Science; Ph.D., University of New Hampshire, 1971; appointed 1972.

**Hubbard, Colin D.**

Associate Professor of Chemistry; Ph.D., University of Sheffield, 1964; appointed 1967.

**Hudon, Edna S.**

Associate Professor of French; Ph.D., Yale University, 1955; appointed 1961.

**Hudon, Louis J.**

Professor of French; Ph.D., Yale University, 1943; appointed 1961.

**Hurd, Richard W.**

Assistant Professor of Economics; Ph.D., Vanderbilt University, 1972; appointed 1973.

**Ikawa, Miyoshi**

Professor of Biochemistry; Ph.D., University of Wisconsin, 1948; appointed 1963.

**Irwin, Manley R.**

Professor of Economics; Ph.D., Michigan State University, 1963; appointed 1963.

**Jacoby, Robb**

Professor of Mathematics; Ph.D., University of Chicago, 1946; appointed 1961.

**James, Marion E.**

Associate Professor of History; Ph.D., Radcliffe College, 1955; appointed 1955.

**Jansen, Edmund F., Jr.**

Associate Professor of Resource Economics; Ph.D., North Carolina State University, 1966; appointed 1969.

**Jellison, Charles A., Jr.**

Professor of History; Ph.D., University of Virginia, 1956; appointed 1956.

**Jenks, R. Stephen**

Associate Professor of Organizational Behavior; Ph.D., Case Institute, 1966; appointed 1967.

**Jervis, Frederick M.**

Adjunct Professor of Education; Ph.D., Columbia University, 1958; appointed 1973.

**Johnson, Richard E.**

Professor of Mathematics; Ph.D., University of Wisconsin, 1941; appointed 1966.

**Jones, Galen E.**

Professor of Microbiology; Ph.D., Rutgers University, 1956; appointed 1966.

**Jones, Paul R.**

Professor of Chemistry; Ph.D., University of Illinois, 1956; appointed 1956.

**Jones, William R.**

Professor of History; Ph.D., Harvard University, 1958; appointed 1962.

**Kaen, Fred R.**

Assistant Professor of Finance; Ph.D., University of Michigan, 1968; appointed 1973.

**Kaufmann, Richard L.**

Professor of Physics; Ph.D., Yale University, 1960; appointed 1963.

**Kayser, John R.**

Associate Professor of Political Science; Ph.D., Claremont Graduate School and University Center, 1969; appointed 1969.

**Keener, Harry A.**

Dean of the College of Life Science and Agriculture, Director of the Agricultural Experiment Station, and Professor of Animal Science; Ph.D., Pennsylvania State College, 1941; appointed 1941.

**Kemnitz, Thomas M.**

Assistant Professor of History; Ph.D., University of Sussex, 1969; appointed 1969.

**Kertzer, Robert**

Associate Professor of Physical Education; Ph.D., Michigan State University, 1965; appointed 1965.

**Khleif, Bud B.**

Associate Professor of Sociology and Education; Ph.D., Johns Hopkins University, 1957; appointed 1967.

**Kiang, Yun Tzu**

Assistant Professor of Plant Sciences and Genetics; Ph.D., University of California, 1970; appointed 1970.

**Kimball, Roland B.**

Professor of Education; Ed.D., Harvard University, 1958; appointed 1963.

**Klippenstein, Gerald L.**

Associate Professor of Biochemistry; Ph.D., Northwestern University, 1967; appointed 1967.

**Klotz, Louis H.**

Associate Professor of Civil Engineering; Ph.D., Rutgers University, 1967; appointed 1965.

**Koch, David W.**

Assistant Professor of Plant Science; Ph.D., Colorado State University, 1971; appointed 1971.

**Kolodny, Annette**

Assistant Professor of English; Ph.D., University of California at Berkeley, 1969; appointed 1974.

**Korbel, John**

Professor of Economics and Business Administration; Ph.D., Harvard University, 1959; appointed 1966.

**Kuo, Shan S.**

Professor of Applied Mathematics; D.Eng., Yale University, 1958; appointed 1964.

**Ladd, Dwight R.**

Professor of Business Administration; D.B.A., Harvard University, 1956; appointed 1964.

**Lambert, Robert H.**

Professor of Physics; Ph.D., Harvard University, 1963; appointed 1961.

**Langley, Harold E., Jr.**

Associate Professor of Civil Engineering; Sc.D., Massachusetts Institute of Technology, 1957; appointed 1961.

**Larson, David L.**

Associate Professor of Political Science; Ph.D., Fletcher School, Tufts University, 1963; appointed 1965.

**Lavoie, Marcel E.**

Associate Professor of Zoology; Ph.D., Syracuse University, 1956; appointed 1950-52, 1955.

**Lawton, Edward J.**

Assistant Professor of Education; Ed.D., University of Virginia, 1970; appointed 1970.

**Leak, William B.**

Adjunct Associate Professor of Forest Resources, M.F., S.U.N.Y., College of Forestry, Syracuse University, 1956; appointed 1967.

**Leighton, Charles H.**

Professor of Spanish; Ph.D., Harvard University, 1961; appointed 1956.

**LeRay, Nelson L., Jr.**

Adjunct Professor of Resource Economics; Ed.D., Cornell University, 1965; appointed 1966.

**Limber, John E.**

Assistant Professor of Psychology; Ph.D., University of Illinois, 1968; appointed 1971.

**Limbert, David E.**

Associate Professor of Mechanical Engineering; Ph.D., Case Western Reserve University, 1969; appointed 1969.

**Lindberg, Gary H.**

Associate Professor of History; Ph.D., Stanford University, 1967; appointed 1974.

**Linden, Allen B.**

Assistant Professor of History; Ph.D., Columbia University, 1969; appointed 1963.

**Linsky, Arnold S.**

Associate Professor of Sociology; Ph.D., University of Washington, 1966; appointed 1966.

**Lockwood, John A.**

Acting Associate Director of Research and Professor of Physics; Ph.D., Yale University, 1948; appointed 1968.

**Loder, Theodore C., III**

Assistant Professor of Earth Sciences; Ph.D., University of Alaska, 1971; appointed 1972.

**Logan, Terence P.**

Associate Professor of English; Ph.D., Harvard University, 1966; appointed 1968.

**Long, David F.**

Professor of History; Ph.D., Columbia University, 1950; appointed 1948.

**Loy, James B.**

Associate Professor of Plant Sciences and Genetics; Ph.D., Colorado State University, 1967; appointed 1967.

**Lyle, Gloria G.**

Associate Professor of Chemistry; Ph.D., University of New Hampshire, 1958; appointed 1951.

**Lyle, Robert E., Jr.**

Professor of Chemistry; Ph.D., University of Wisconsin, 1949; appointed 1951.

**MacHardy, William E.**

Assistant Professor of Plant Pathology; Ph.D., University of Rhode Island, 1970; appointed 1972.

**Marschner, Donald C.**

Professor of Business Administration; Ph.D., Columbia University, 1964; appointed 1964.

**Marshall, Grover E.**

Assistant Professor of French and Italian; Ph.D., Princeton University, 1971; appointed 1965.

**Marshall, Thomas O.**

Professor of Education; Ed.D., Harvard University, 1941; appointed 1947.

**Mathieson, Arthur C.**

Professor of Botany; Ph.D., University of British Columbia, 1965; appointed 1965.

**Mathur, Virendra K.**

Visiting Assistant Professor; Ph.D., University of Missouri at Rolla, 1970; appointed 1974.

**Mautz, William W.**

Associate Professor of Wildlife Ecology; Ph.D., Michigan State University, 1969; appointed 1969.

**Mayewski, Paul A.**

Assistant Professor of Earth Sciences; Ph.D., Ohio State University, 1973; appointed 1974.

**McCann, Francis D., Jr.**

Associate Professor of History; Ph.D., Indiana University, 1967; appointed 1971.

**Meeker, Loren David**

Associate Professor of Mathematics; Ph.D., Stanford University, 1965; appointed 1970.

**Melvin, Donald W.**

Associate Professor of Electrical Engineering; Ph.D., Syracuse University, 1970; appointed 1957.

**Menge, Carleton P.**

Professor of Education; Ph.D., University of Chicago, 1948; appointed 1948.

**Mennel, Robert M.**

Associate Professor of History; Ph.D., Ohio State University, 1969; appointed 1969.

**Merton, Andrew H.**

Assistant Professor of English; B.A., University of New Hampshire, 1967; appointed 1972.

**Metcalé, Theodore G.**

Professor of Microbiology; Ph.D., University of Kansas, 1950; appointed 1956.

**Miaoulis, George**

Assistant Professor of Business Administration; Ph.D., New York University, 1973; appointed 1973.

**Miller, Edmund G.**

Professor of English; Ph.D., Columbia University, 1955; appointed 1951.

**Mills, Eugene S.**

President and Professor of Psychology; Ph.D., Claremont Graduate School, 1952; appointed 1962.

**Mills, Richard L.**

Associate Professor of Economics and Business Administration; Ph.D., Indiana University, 1967; appointed 1967.

**Milne, Lorus J.**

Professor of Zoology; Ph.D., Harvard University, 1936; appointed 1948.

**Minocha, Subhash**

Assistant Professor of Botany; Ph.D., University of Washington, 1974; appointed 1974.

**Moore, Berrien, III**

Associate Professor of Mathematics; Ph.D., University of Virginia, 1969; appointed 1969.

**Moore, David W.**

Assistant Professor of Political Science; Ph.D., Ohio State University, 1970; appointed 1972.

**Morris, Douglas E.**

Assistant Professor of Resource Economics; Ph.D., Oklahoma State University, 1972; appointed 1972.

**Morrison, James D.**

Professor of Chemistry; Ph.D., Northwestern University, 1963; appointed 1965.

**Mosberg, William**

Associate Professor of Mechanical Engineering; M.Eng., Yale University, 1960; appointed 1958.

**Mott, Basil J.F.**

Dean of School of Health Studies and Professor of Health Services Administration and Planning; Ph.D., Harvard University, 1967; appointed 1973.

**Mower, Lyman**

Professor of Physics; Ph.D., Massachusetts Institute of Technology, 1953; appointed 1957.

**Mulhern, John E., Jr.**

Professor of Physics; Ph.D., Boston University, 1954; appointed 1954.

**Munroe, M. Evans**

Professor of Mathematics; Ph.D., Brown University, 1945; appointed 1959.

**Murdoch, Joseph B.**

Professor of Electrical Engineering; Ph.D., Case Institute of Technology, 1962; appointed 1952.

**Murphy, Stephen T.**

Assistant Professor of Education; Ph.D., State University of New York at Buffalo, 1973; appointed 1974.

**Murray, Donald M.**

Professor of English; B.A., University of New Hampshire, 1948; appointed 1963.

**Nevin, John A.**

Professor of Psychology; Ph.D., Columbia University, 1963; appointed 1972.

**Nicoloff, Philip L.**

Professor of English; Ph.D., Columbia University, 1959; appointed 1954.

**Nielson, Melville**

Associate Dean of the College of Liberal Arts and Associate Professor of Sociology; Ph.D., Ohio State University, 1955; appointed 1950.

**Nordell, Lawrence P.**

Associate Professor in Economics; Ph.D., University of California at Berkeley, 1967; appointed 1972.

**Nordgren, Eric A.**

Professor of Mathematics; Ph.D., University of Michigan, 1964; appointed 1964.

**O'Brien, Dennis J.**

Assistant Professor of Civil Engineering; Ph.D., University of Maryland, 1974; appointed 1974.

**O'Connell, Lawrence W.**

Associate Professor of Political Science; Ph.D., Syracuse University, 1968; appointed 1966.

**O'Connor, James T., Jr.**

Lecturer in Animal Science and Extension Animal Scientist; D.V.M., University of Pennsylvania, 1941; appointed 1969.

**Olson, David P.**

Associate Professor of Wildlife Ecology; Ph.D., University of Minnesota, 1964; appointed 1964.

**Owens, Charles W.**

Associate Professor of Chemistry; Ph.D., University of Kansas, 1963; appointed 1963.

**Palmer, Stuart H.**

Professor of Sociology; Ph.D., Yale University, 1955; appointed 1955.

**Paul, Nicholas L.**

Assistant Professor of Occupational Education; Ed.D., North Carolina State University, 1973; appointed 1973.

**Peirce, Lincoln C.**

Professor of Plant Science and Genetics; Ph.D., University of Minnesota, 1958; appointed 1964.

**Peterson, Nobel K.**

Associate Professor of Soil and Water Science; Ph.D., Rutgers University, 1957; appointed 1957.

**Petroski, Joseph J.**

Associate Professor of Education; Ed.D., Harvard University, 1960; appointed 1964.

**Pfanner, Helmut F.**

Associate Professor of German; Ph.D., Stanford University, 1965; appointed 1969.

**Pierce, Robert S.**

Adjunct Associate Professor of Forest Resources and Soil and Water Science; Ph.D., University of Wisconsin, 1957; appointed 1967.

**Pilar, Frank L.**

Professor of Chemistry; Ph.D., University of Cincinnati, 1957; appointed 1957.

**Pine, Gerald J.**

Professor of Education; Ed.D., Boston University, 1963; appointed 1966.

**Pistole, Thomas G.**

Assistant Professor of Microbiology; Ph.D., University of Utah, 1969; appointed 1971.

**Pokoski, John L.**

Associate Professor of Electrical Engineering; Ph.D., Montana State University, 1967; appointed 1967.

**Polk, Keith**

Associate Professor of Music; Ph.D., University of California at Berkeley, 1968; appointed 1964.

**Poll, Solomon**

Professor of Sociology; Ph.D., University of Pennsylvania, 1960; appointed 1964.

**Pollard, James E.**

Assistant Professor of Plant Science; Ph.D., University of Florida, 1969; appointed 1970.

**Potter, Hugh M., III**

Assistant Professor of English; Ph.D., University of Minnesota, 1965; appointed 1962.

**Prince, Allan B.**

Vice Provost for Budget and Administration and Professor of Soil and Water Science; Ph.D., Rutgers University, 1950; appointed 1954.

**Puth, Robert C.**

Associate Professor of Economics; Ph.D., Northwestern University, 1967; appointed 1967.

**Radlow, James**

Professor of Applied Mathematics; Ph.D., New York University, 1957; appointed 1965.

**Rand, M. Elizabeth**

Associate Professor of Home Economics; M.Ed., Boston University, 1946; appointed 1948.

**Rasmussen, Mary H.**

Associate Professor of Music; M.M., University of Illinois, 1952; M.L.S., University of Illinois, 1956; appointed 1968.

**Reeves, Roger Marcel**

Associate Professor of Entomology and Forest Resources; Ph.D., S.U.N.Y. College of Forestry, Syracuse University, 1964; appointed 1964.

**Reid, Samuel R.**

Professor of Business Administration and Economics; Ph.D., St. Louis University, 1962; appointed 1969.

**Repka, Frank J.**

Assistant Professor of Animal Science; Ph.D., Cornell University, 1972; appointed 1972.

**Reyna, Stephen P.**

Assistant Professor of Anthropology; Ph.D., Columbia University, 1972; appointed 1973.

**Rich, Avery E.**

Associate Dean of College of Life Sciences and Agriculture and Professor of Plant Pathology; Ph.D., State College of Washington, 1950; appointed 1941-43, 1951

**Richardson, John C.**

Professor of English; Ph.D., Boston University, 1959; appointed 1946.

**Ringrose, Richard C.**

Professor of Animal Science; Ph.D., Cornell University, 1936; appointed 1942.

**Roelofs, Edmond C.**

Assistant Professor of Physics; Ph.D., University of California at Berkeley, 1966; appointed 1971.

**Rogers, John E.**

Associate Professor of Music; M.F.A., Princeton University, 1966; appointed 1967.

**Rogers, Owen M.**

Professor of Plant Science and Genetics; Ph.D., Pennsylvania State University, 1959; appointed 1959.

**Romoser, George K.**

Professor of Political Science; Ph.D., University of Chicago, 1958; appointed 1961-62, 1967.

**Rose, Alan H.**

Assistant Professor of English; Ph.D., Indiana University, 1970; appointed 1969.

**Rosen, Sam**

Professor of Economics; Ph.D., Harvard University, 1952; appointed 1957.

**Rosenbush, Michael J.**

Assistant Professor of Russian; Ph.D., Université de Montreal, 1970; appointed 1972.

**Ross, Shepley L.**

Professor of Mathematics; Ph.D., Boston University, 1953; appointed 1955.

**Rothwell, Kenneth J.**

Professor of Economics; Ph.D., Harvard University, 1961; appointed 1963.



**Rouman, John C.**

Associate Professor of Classics; Ph.D., University of Wisconsin, 1965; appointed 1965.

**Routley, Douglas G.**

Professor of Plant Science; Ph.D., Pennsylvania State University, 1957; appointed 1957.

**Rutman, Darrett B.**

Professor of History; Ph.D., University of Virginia, 1959; appointed 1968.

**Sabatelli, Philip J.**

Assistant Professor of Speech and Drama; Ph.D., Temple University, 1970; appointed 1969.

**St. Onge, Richard N.**

Assistant Professor of Physics; Ph.D., University of New Hampshire, 1969; appointed 1970.

**Samuels, Fred**

Associate Professor of Sociology; Ph.D., University of Massachusetts, 1966; appointed 1966.

**Sasner, John J., Jr.**

Associate Professor of Zoology; Ph.D., University of California, 1965; appointed 1965.

**Savage, Godfrey H.**

Professor of Mechanical Engineering; Ph.D., Stanford University, 1970; appointed 1965.

**Sawyer, Albert K.**

Professor of Chemistry; M.S., University of Maine, 1947; appointed 1949.

**Sawyer, Philip I.**

Professor of Zoology; Ph.D., University of Michigan, 1956; appointed 1952.

**Schibanoff, Susan**

Assistant Professor of English; Ph.D., University of California at Los Angeles, 1971; appointed 1971.

**Schickedanz, David I.**

Assistant Professor of Psychology; Ph.D., University of Illinois, 1973; appointed 1973.

**Schmidt, Marty J.**

Assistant Professor of Psychology; Ph.D., Purdue University, 1972; appointed 1972.

**Schneer, Cecil J.**

Professor of Geology; Ph.D., Cornell University, 1954; appointed 1950, 1954.

**Schreiber, Richard W.**

Professor of Botany; Ph.D., University of Wisconsin, 1955; appointed 1957.

**Schulz, Ann T.**

Assistant Professor of Political Science; Ph.D., Yale University, 1969; appointed 1969.

**Schwarz, Marc L.**

Associate Professor of History; Ph.D., University of California at Los Angeles, 1965; appointed 1967.

**Shapiro, Howard M.**

Associate Professor of Sociology; Ph.D., University of Minnesota, 1969; appointed 1969.

**Shar, Albert O.**

Assistant Professor of Mathematics; Ph.D., University of Pennsylvania, 1970; appointed 1971.

**Shepard, Harvey K.**

Associate Professor of Physics; Ph.D., California Institute of Technology, 1966; appointed 1969.

**Sherman, Heidemarie C.**

Assistant Professor of Economics; Ph.D., Wayne State University, 1971; appointed 1967.

**Sherman, James L.**

Assistant Professor of German; Ph.D., University of Michigan, 1969; appointed 1967.

**Shigo, Alex L.**

Adjunct Professor of Plant Pathology; Ph.D., West Virginia University, 1959; appointed 1967.

**Shor, Ronald E.**

Professor of Psychology; Ph.D., Brandeis University, 1960; appointed 1967.

**Shore, Samuel D.**

Associate Professor of Mathematics; Ph.D., Pennsylvania State University, 1964; appointed 1965.

**Siddall, David V.**

Assistant Professor of English; Ph.D., Indiana University, 1970; appointed 1965.

**Silver, Judith A.**

Assistant Professor of History; Ph.D., University of Michigan, 1973; appointed 1973.

**Silverman, Robert J.**

Professor of Mathematics; Ph.D., University of Illinois, 1952; appointed 1962.

**Simic, Charles D.**

Assistant Professor of English; B.A., New York University, 1967; appointed 1973.

**Simpson, Robert E.**

Associate Professor of Physics; Ph.D., Harvard University, 1960; appointed 1963.

**Sir, W. Niel**

Assistant Professor of Music; M.A., University of California, 1962; appointed 1970.

**Sivaprasad, Kondagunta**

Associate Professor of Electrical Engineering; Ph.D., Harvard University, 1963; appointed 1969.

**Skoglund, Winthrop C.**

Professor of Animal Science; Ph.D., Pennsylvania State University, 1958; appointed 1950.

**Slanetz, Lawrence W.**

Professor of Microbiology; Ph.D., Yale University, 1932; appointed 1932.

**Smith, Gerald L.**

Associate Professor of Animal Science; M.S., Pennsylvania State College, 1951; appointed 1948.

**Smith, M. Daniel**

Associate Professor of Education; Ed.D., Harvard University, 1961; appointed 1967.

**Smith, Elizabeth C.**

Lecturer in Animal Science; Ph.D., Pennsylvania State University, 1958; appointed 1968.

**Smith, James A.**

Associate Dean of the College of Liberal Arts and Adjunct Associate Professor of Economics; Ph.D., Washington State University, 1967; appointed 1972.

**Smith, Mark R.**

Associate Professor of English; B.A., Northwestern University, 1960; appointed 1966.

**Smith, Roderick M.**

Assistant Professor of Zoology; Ph.D., University of Massachusetts, 1969; appointed 1974.

**Smith, Samuel C.**

Professor of Animal Science and Biochemistry; Ph.D., Pennsylvania State University, 1962; appointed 1961.

**Snell, Elizabeth A.**

Associate Professor of Home Economics; Ph.D., Cornell University, 1971; appointed 1971.

**Spitz, Allan A.**

Dean of the College of Liberal Arts and Professor of Political Science; Ph.D., Michigan State University, 1964; appointed 1971.

**Sprague, Linda G.**

Assistant Professor of Business Administration; M.B.A., Boston University, 1967; appointed 1969.

**Squires, Edward L.**

Assistant Professor of Animal Science; M.S., West Virginia University, 1973; appointed 1973.

**Stackhouse, Larry L.**

Associate Professor of Animal Science; Ph.D., Colorado State University, 1970; appointed 1970.

**Steele, Donald E.**

Professor of Music; M.A., Colorado College, 1952; appointed 1946.

**Stewart, Glenn W.**

Associate Professor of Geology; M.A., Harvard University, 1950; appointed 1938-39, 1941.

**Stewart, James A.**

Assistant Professor of Biochemistry; Ph.D., University of Connecticut, 1967; appointed 1968.

**Stone, Deborah E.**

Associate Professor of Education; Ed.D., Boston University, 1971; appointed 1962.

**Stotz, Kerwin C.**

Associate Professor of Electrical Engineering; Ph.D., Rensselaer Polytechnic Institute, 1963; appointed 1964.

**Straus, Murray A.**

Professor of Sociology; Ph.D., University of Wisconsin, 1956; appointed 1968.

**Strout, Richard G.**

Professor of Animal Science; Ph.D., University of New Hampshire, 1961; appointed 1954.

**Swan, Emery F.**

Professor of Zoology; Ph.D., University of California, 1942; appointed 1952.

**Taft, Charles K.**

Professor of Mechanical Engineering; Ph.D., Case Institute of Technology, 1960; appointed 1967.

**Tattar, Terry A.**

Adjunct Assistant Professor of Plant Pathology; Ph.D., University of New Hampshire, 1971; appointed 1972.

**Teeri, Arthur E.**

Professor of Biochemistry; Ph.D., Rutgers University, 1943; appointed 1938-40, 1943.

**Thompson, Alan R.**

Assistant Professor of Economics; Ph.D., University of Texas at Austin, 1973; appointed 1974.

**Tillinghast, Edward K.**

Associate Professor of Zoology; Ph.D., Duke University, 1966; appointed 1967.

**Tischler, Herbert**

Professor of Geology; Ph.D., University of Michigan, 1961; appointed 1965.

**Trout, Ben T.**

Assistant Professor of Political Science; Ph.D., University of Indiana, 1972; appointed 1969.

**Uebel, J. John**

Associate Professor of Chemistry; Ph.D., University of Illinois, 1964; appointed 1964.

**Ulrich, Gail D.**

Assistant Professor of Chemical Engineering; Sc.D., Massachusetts Institute of Technology, 1964; appointed 1970.

**Urban, Willard E., Jr.**

Associate Professor of Biometrics and Genetics; Ph.D., Iowa State University, 1963; appointed 1963.

**Valentine, Russell L.**

Associate Professor of Mechanical Engineering; M.S.M.E., Purdue University, 1953; appointed 1953.

**Van Osdol, Donovan Harold**

Associate Professor of Mathematics; Ph.D., University of Illinois, 1969; appointed 1970.

**Verrette, Paul F.**

Assistant Professor of Music; M.A., Boston University, 1971; appointed 1962.

**Vincent, Donald E.**

Professor, Librarian; A.M., University of Michigan, 1957; appointed 1962.

**Voll, John O.**

Associate Professor of History; Ph.D., Harvard University, 1969; appointed 1965.

**Vreeland, Robert P.**

Associate Professor of Civil Engineering; M.E., Yale University, 1941; appointed 1966.

**Vrooman, Jack R.**

Associate Professor of French; Ph.D., Princeton University, 1965; appointed 1971.

**Wallace, Oliver P., Sr.**

Associate Professor of Forest Resources; Ph.D., University of Michigan, 1954; appointed 1953.

**Wang, Tung-Ming**

Associate Professor of Civil Engineering; Ph.D., Northwestern University, 1960; appointed 1961.

**Warren, Jerry A.**

Director of Academic Computer Activities, Associate Professor of Plant Science; Ph.D., Cornell University, 1960; appointed 1971.

**Watson, Robert I.**

Professor of Psychology; Ph.D., Columbia University, 1938; appointed 1967.

**Wear, Robert E.**

Associate Professor of Physical Education; Ph.D., University of Michigan, 1955; appointed 1964.

**Webb, Dwight**

Associate Professor of Education; Ph.D., Stanford University, 1967; appointed 1967.

**Webber, William R.**

Professor of Physics; Ph.D., University of Iowa, 1957; appointed 1969.

**Weber, James H.**

Associate Professor of Chemistry; Ph.D., Ohio State University, 1963; appointed 1963.

**Weber, Stephen J.**

Assistant Professor of Psychology; Ph.D., Northwestern University, 1971; appointed 1971.

**Weesner, Theodore W.**

Associate Professor of English; M.F.A., University of Iowa, 1965; appointed 1966.

**Weiland, Walter E.**

Associate Professor of Physical Education; Ph.D., Pennsylvania State University, 1964; appointed 1964.

**Wells, Donald D.**

Instructor in Business Administration; M.B.A., University of Connecticut, 1968; appointed 1971.

**Wells, Otho S.**

Associate Professor of Plant Science; Ph.D., Rutgers University, 1966; appointed 1966.

**Wetzel, William E.**

Associate Professor of Business Administration; M.B.A., Temple University, 1965; appointed 1967.

**Weyrick, Richard R.**

Associate Professor of Forest Resources; Ph.D., University of Minnesota, 1968; appointed 1964.

**Wheeler, Charles M., Jr.**

Associate Professor of Chemistry; Ph.D., West Virginia University, 1951; appointed 1950.

**Wheeler, Douglas L.**

Associate Professor of History; Ph.D., Boston University, 1963; appointed 1965.

**Wheeler, Ellsworth H., Jr.**

Assistant Professor of Zoology; Ph.D., University of Rhode Island, 1968; appointed 1970.

**White, Susan O.**

Assistant Professor of Political Science; Ph.D., University of Minnesota, 1970; appointed 1969.

**Whitlock, John B.**

Associate Professor of Music; Ph.D., State University of Iowa, 1958; appointed 1958.

**Wicks, John D.**

Professor of Music; Ph.D., Harvard University, 1959; appointed 1956.

**Wilcox, Donald J.**

Associate Professor of History; Ph.D., Harvard University, 1967; appointed 1970.

**Williams, Daniel C.**

Assistant Professor of Psychology; Ph.D., University of California at Santa Barbara, 1970; appointed 1970.

**Williams, Thomas A., Jr.**

Professor of English; M.A., University of New Hampshire, 1958; appointed 1958.

**Willits, Robin D.**

Professor of Business Administration; Ph.D., Massachusetts Institute of Technology, 1965; appointed 1965.

**Wilson, John A.**

Associate Professor of Mechanical Engineering; Ph.D., Northeastern University, 1970; appointed 1960.

**Winn, Alden L.**

Professor of Electrical Engineering; S.M., Massachusetts Institute of Technology, 1948; appointed 1948.

**Wright, John J.**

Assistant Professor of Physics; Ph.D., University of New Hampshire, 1969; appointed 1970.

**Wright, Paul A.**

Professor of Zoology; Ph.D., Harvard University, 1944; appointed 1958.

**Wrightsman, Dwayne E.**

Professor of Finance; Ph.D., Michigan State University, 1964; appointed 1964.

**Wurzburg, Frederic W.**

Associate Professor of Political Science; Ph.D., Columbia University, 1961; appointed 1963.

**Wyman, Charles E.**

Assistant Professor of Chemical Engineering; Ph.D., Princeton University, 1970; appointed 1970.

**Yildiz, Asim**

Professor of Mechanics; D.Eng., Yale University, 1960; appointed 1967.

**Yildiz, Musa**

Visiting Professor in Applied Mathematics; Ph.D., Stevens Institute of Technology, 1967; appointed 1972.

**Yount, John A.**

Associate Professor of English; M.F.A., State University of Iowa, 1962; appointed 1962-64, 1965.

**Zoller, J. Harold**

Professor of Civil Engineering; Ph.D., University of Wisconsin, 1953; appointed 1958.

**Zsigray, Robert M.**

Assistant Professor of Microbiology and Genetics; Ph.D., Georgetown University, 1968; appointed 1970.

# Rules Governing Residency

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## **I. Basic Rule**

All students attending any division of the University of New Hampshire in any capacity shall be charged tuition at a rate to be determined by their domicile. Those domiciled within the State of New Hampshire shall pay the in-state rate. Those domiciled elsewhere shall pay the out-of-state rate.

## **II. Determination of Tuition Rates**

**A. In-State:** The Board of Trustees shall fix the in-state tuition rate annually on the basis of their projected budget including as part of said budget the applicable funds made available by the Legislature in its biennial budget.

**B. Out-of-State:** In accordance with the policy established by the Legislative Budget Act, the out-of-state tuition rate shall be set annually by the Board of Trustees at a figure which reflects actual cost of per capita operating costs, including instructional expenses, overhead, and bond retirement (excluding self-liquidating bonds), as determined by the costs in the fiscal year just preceding the first of January for the fiscal year in which tuition is to be charged, all in accordance with the established accounting practices of the University.

## **III. Determination of Student Status**

A student shall be classified as in-state or out-of-state for tuition purposes at the time of his first admission to the University. The decision shall be made by the director of admissions of the appropriate division in the first instance based upon information furnished by the student's application and other relevant information available to the director.

## **IV. Review of Student Status**

Any student who is aggrieved by the decision of the director of admissions classifying him as an out-of-state student for tuition purposes may appeal to the Appeal Committee of the appropriate division on forms and in accordance with the procedures which shall be made available to the students in the office of the director of admissions. The student shall have the right to present to the Appeals Committee such additional evidence as he may deem appropriate in processing his appeal, and shall have the right to appear in person and be heard.

The decision of the Appeals Committee shall be final unless the Board of Trustees in its discretion elects to review the record before the Committee. No evidence may be adduced or presented before the full Board of Trustees, but review shall be of the record only.

## **V. Change in Status**

Any student who has, on his first admission to the University, been classified as out-of-state for tuition purposes, may apply to the director of admissions for a change of status on or before September 1 of any year for the fall semester, and on or before January 1 of any year for the spring semester. Applications shall be considered in the chronological order in which they are presented. No changes approved during a semester shall be effective until the beginning of the next following semester. Provided, however, that where a change of status from out-of-state to in-state has been denied by the director of admissions prior to the commencement of a semester, and his decision is reversed by the Appeals Committee or the Board of Trustees during the semester, the student's status shall be effective as of the commencement of the semester.

In the event the director of admissions possesses facts or information indicating that a student's status should be changed from in-state to out-of-state, the student shall be in-

formed in writing of the change of status. The student may appeal the decision of the director as hereinabove set forth. No such change made by the director after the commencement of any semester shall be effective until the beginning of the next semester. Change of out-of-state status made by the director prior to the commencement of any semester, but reversed during the semester by the Board of Appeals, shall be effective as of the commencement of the semester.

## **VI. Application Forms**

Each applicant for in-state status for tuition purposes shall submit an application on forms to be prescribed by the director of admissions which shall include a sworn statement certifying that the applicant is legally domiciled within the State of New Hampshire. The application shall also include such additional information as the director may require in support of the affidavit of domicile. In his discretion, the director may require resubmission of an application form from any in-state student prior to the commencement of each semester the student plans to attend the University.

## **VII. Substantive Rules**

In all cases of application for in-state status for tuition purposes, the burden of proof shall be on the applicant. At the applicant's request, the director of admissions shall state the reason or reasons for his decision in writing.

**For the purposes of determining tuition status, the following definitions and rules shall prevail:**

A. The term "parent" shall mean a person's father; or if he has no father, his mother; or if one parent has custody of an unemancipated person, the parent having custody; or if there is a guardian or legal custodian, provided that there are no circumstances indicating that such guardianship or custodianship was created primarily for the purpose of conferring the status of an in-state student on such unemancipated person.

B. No person shall be eligible for in-state tuition status unless he shall have been domiciled within the state continuously for a period of at least twelve months immediately prior to registering for the term for which in-state status is claimed.

C. No unemancipated person shall be eligible for in-state tuition status unless his parent shall have established domicile in this state.

D. No person shall be eligible for in-state tuition status unless he establishes that his residence in New Hampshire is for some purpose other than the temporary or primary one of obtaining an education.

E. "Domicile" denote's a person's true, fixed, and permanent home and place of habitation. It is the place where he intends to remain and to which he expects to return when he leaves without intending to establish a new domicile elsewhere.

All evidence relevant to determining domicile may be considered, but the following indicia shall, in any cases, be relevant, without limiting in any way such other information as the applicant may wish to submit or the director may wish to require:

- i. Payment or non-payment of any tax levied by the state or any political subdivision on persons resident or domiciled thereon.
- ii. Residence reported on any federal or state tax return.
- iii. Registration of one's automobile.
- iv. State issuing one's driver's license.
- v. Receipt of support in whole or in part from parents who are resident or domiciled outside the State of New Hampshire.
- vi. Voting residence.
- vii. Claim by any non-resident parent that the applicant is a dependent for tax or any other financial purpose.
- viii. Regular departure by an applicant from the State of New Hampshire during recesses or vacations from the University.

ix. The filing of any claim for benefits under any policy of insurance or any federal, state, or local benefit legislation based on residence or domicile outside the State of New Hampshire.

x. Status in some other state which would qualify a person for in-state tuition in that state.

F. Unless the contrary appears to the satisfaction of the director of admissions in individual cases, the following presumptions shall prevail:

- i. The domicile of an unemancipated person is that of his parents, or if his parents are separated or divorced, that of the parent who has custody of him.
- ii. The domicile of an unemancipated person who has no parents is that of his guardian or other legal custodian, unless it appears that such guardianship or custodianship was created for the purpose of establishing an in-state status.
- iii. The domicile of any person who first enters the University from the domicile of his parent, as defined in subparagraph A above, is that of his parent until he abandons such domicile, and, for purposes other than that of his education, acquires a new domicile.
- iv. The domicile of any person who first enters the University from a domicile other than New Hampshire is such a domicile until he abandons such domicile and, for purposes other than that of his education, acquires a new domicile.
- v. Attendance at the University or at any other educational institution in this state in itself shall not be evidence of intention to establish or establishment of a domicile in this state.

G. No person shall be deemed to be emancipated unless his parent, as defined in subparagraph A above, has entirely surrendered the right to the care, custody and earnings of such person and unless his parent is no longer under any legal obligation to support or maintain such person or, having supported and maintained such person even though under no legal obligation to do so, has ceased to support or maintain such person. Emancipation shall not be found unless all such tests are met. The following shall be indicia of emancipation, but shall not be exclusive, and other evidence may be submitted by an applicant and demanded by the director of admissions:

- i. Lack of financial support of the person by the parent.
- ii. Lack of contribution to the parent of any earnings or other income received by the person.
- iii. Failure of the parent to claim the person as a dependent on his income or other tax returns.
- iv. Establishment by the person of a domicile separate and apart from that of the parent.
- v. Failure of the person to return to the home of the parent during vacations and other recesses from school.

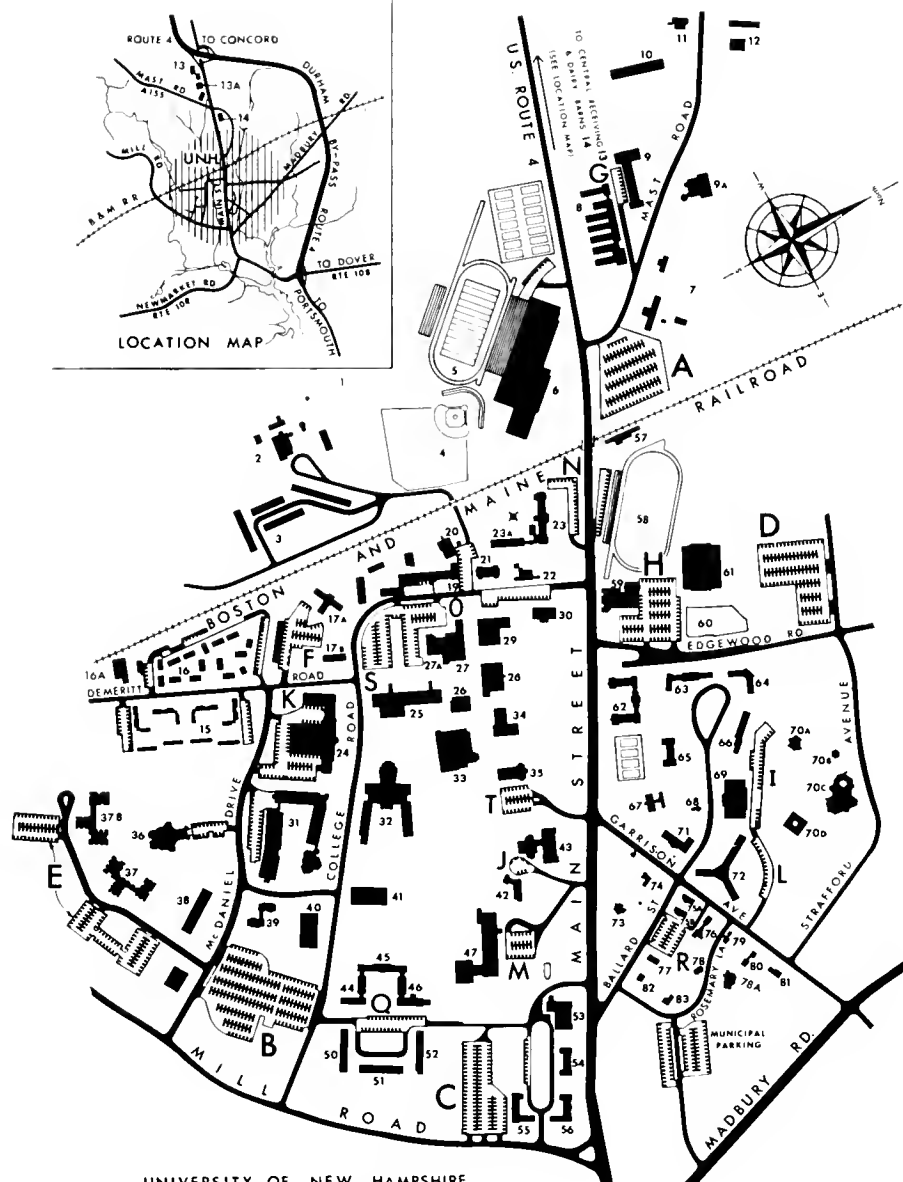
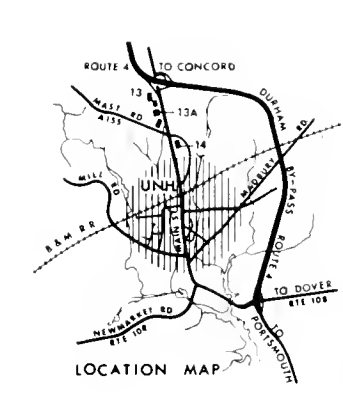
#### **VIII. Waiver**

Nothing contained in these rules shall preclude the director from waiving any requirement hereof under special circumstances in individual cases.

**Approved by University of New Hampshire Board of Trustees, January 20, 1973.  
Amended August 5, 1974.**

# Campus Map and Key

Adams Residential Tower (N.E. Center)	70a	Greenhouses	8	Ombudsman	43
Admissions Office	35	Hamilton Smith Hall	43	Palmer House	78a
Agricultural Experiment Station	22	Health Studies, School of	27	Parsons Hall	31
Agronomy Field Station	11	Hennessy Theater	32	Paul Creative Arts Center	32
Alexander Hall	55	Hersey House	75b	Pettee Hall	21
Alumni House	74	Hetzel Hall	56	Philbrook Dining Hall	36
Analytical Services Laboratory	23	Hewitt Hall	27	Poultry Plant	3
Babcock House	39	Hitchcock Hall	44	President's Office	35
Barton Hall	9a	Hood House Infirmary	42	Provost's Office	35
Batcheller House	78	Horse Barn	10	Public Administration Service	41
Bookstore	27a	Hubbard Hall	38	Putnam Hall	9
Brackett Field	4	Huddleston Hall	53	Randall Hall	45
Brook House	79	Hunter Hall	51	Registrar, Registration & Records	35
Business Office	35	International House	80	Residence Office (Housing)	72
Center for Educational Field Services	30	International Students' Adviser	53	Resources Development Center	82
Center for Industrial and Institutional Development	40	James Hall	29	Richards House	77
Christensen Hall	37	Janetos House	83	Ritzman Nutrition Laboratory	2
College Woods	1	Jessie Doe Hall	66	Safety Services	27
Computation Center	24	Johnson Theater	32	Sawyer Hall	71
Conant Hall	26	Kendall Hall	23a	Schofield House	76
Congreve Hall	62	Kingsbury Hall	24	SCORE Building	17b
Continuing Education, Division of	75a	Language Laboratory	34	Scott Hall	65
Continuing Studies, School of	22	Lewis Fields	5	Sculpture Laboratory	17a
Cooperative Extension Service	22	Liberal Arts, College of	34	Security	19
Counseling and Testing	76	Library	33	Smith Hall	67
Dairy Bar	57	Life Sciences & Agriculture, College of	22	Snively Arena	61
Dairy Barns (location map)	14	Livestock Barn	7	Social Science Center	41
Dean of Students	53	Lord Hall	64	Space Science Center	28
DeMeritt Hall	28	McConnell Hall	40	Spaulding Life Science Building	25
Devine Hall	46	McLaughlin Hall	63	Stillings Dining Hall	69
Dimond Library	33	Media Services	33	Stoke Hall	72
East-West Park	47a	Memorial Union Building	47	Swimming Pool	60
Elizabeth DeMeritt House	81	Mini Dorms	37c	Taylor Hall	22
Engineering Design & Analysis Lab	24	Morrill Hall	30	Technology, College of	24
Engelhardt Hall	52	Murkland Hall	34	Thompson Hall	35
Fairchild Hall	54	Natural & Environmental Resources, Institute of	29	Thompson School of Applied Science	9a
Farm Service Building	12	Nesmith Hall	23	Tickets, Athletic	6
Field House	6	New England Center for Continuing Education	70	Tickets, Cultural Events	47
Financial Aid	35	New Hampshire Hall	59	Verrette House	75a
Fire Station & Service Building	19	Nursery School	68	Water Resources Research Center	21
Forest Park Apartments	15, 16	O'Connell House	84	Williamson Hall	37a
Gibbs Hall	50			WENH-TV	47
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				Wolff House	82



UNIVERSITY OF NEW HAMPSHIRE  
DURHAM NEW HAMPSHIRE

CAMPUS MAP

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# Graduate School Calendar 1975-76

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## Semester I



August 31, Sunday  
September 2, Tuesday  
September 3, Wednesday  
September 6, Saturday  
September 19, Friday  
September 26, Friday  
October 2, Thursday  
October 25, Saturday  
October 28, Tuesday

November 25, Tuesday  
December 1, Monday  
December 5, Friday  
December 11-12,  
Thursday-Friday  
December 12, Friday

December 15, Monday  
December 20, Saturday  
December 21, Sunday

8 a.m. Residence halls open  
Registration  
8 a.m. Classes begin  
Classes hold Thursday schedule  
Last day to drop courses without \$10 late drop fee  
Last day to add courses  
Last day for partial tuition refund on withdrawal  
Classes hold Friday schedule  
Mid-semester, last day to drop courses or withdraw without academic liability  
7 p.m. Thanksgiving recess begins  
8 a.m. Classes resume; pre-registration Semester II begins  
Last day for final Ph.D. oral examination (December graduation)  
Reading days

Last day for presenting final copies of dissertation or thesis to the Graduate School for binding (December graduation)  
8 a.m. Semester I final exams begin  
6 p.m. Final exams end  
Commencement

## Semester II



January 25, Sunday  
January 26, Monday  
February 6, Friday  
February 13, Friday  
February 23, Monday  
March 19, Friday

March 29, Monday  
April 12, Monday  
May 7, Friday  
May 10-11,  
Monday-Tuesday  
May 12, Wednesday  
May 14, Friday

May 19, Wednesday  
May 23, Sunday

Registration  
8 a.m. Classes begin  
Last day to drop courses without \$10 late drop fee  
Last day to add courses  
Last day for partial tuition refund on withdrawal  
Mid-semester, last day to drop courses or withdraw without academic liability; 7 p.m. Spring recess begins  
8 a.m. Classes resume  
8 a.m. Pre-registration for Semester I, 1976-77 begins  
Last day for final Ph.D. oral examination (May graduation)  
Reading days

8 a.m. Semester II final exams begin  
Last day for presenting final copies of dissertation and thesis to the Graduate School for binding (May graduation)  
Final exams end  
Commencement

The University reserves the right to modify the Calendar subsequent to printing.

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